THE INFLUENCE OF FINANCIAL DECISION MAKING ON CORPORATE GROWTH

A THESIS

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CHAPTER I

INTRODUCTION

One of the principal activities of the managerial group in a corporation is to develop policies that have an impact on the total performance of the corporation. Many of these policies are concerned with variables that are important in the growth of the enterprise.

In every company there is a set of policies that is critical for good growth performance. Some policies are concerned with the products that the company sells and are in terms of improvements on the products or completely new designs of products. Policies of this sort are often found in companies involved in a highly competitive industry. Some other policies are concerned with the interaction of the company and its market and are in terms of marketing variables such as advertising, distribution of the product for sales, product promotion, etc. These policies are commonly found in the non-industrial corporations. Policies may be also concerned with the acquisition and training of new human resources and with the maintenance of good relations with the individual employee and his union. Last but not least, policies dealing with financial problems and questions are found in every company. These policies may deal with expansion of production capacity, use and acquisition of financial funds, price and cost control and the declaration of dividends.

The author became interested in studying the impact that several financial policies have on the growth of corporations. This interest grew from his background and education in the areas of Finance and Business Administration and of Systems Engineering, especially Feedback Dynamics.

In this study, the financial policies of a hypothetical organization are studied, analyzed and improved within the framework of the Feedback Dynamics philosophy and methodology.

A mathematical model is used to focus on the dynamic influence of financial policies on capacity and profit expansion. Each of the financial policies is considered for improvement separately. A simple experimental design, taking different sets of improved policies, is executed. The results of this experimentation serve to build an improved model which is analyzed and compared with the original model. It is concluded that all of the financial policies studied have a significant influence on the behavior of capacity and earnings growth.

CHAPTER II

LITERATURE SURVEY

The literature of Feedback Dynamics applications is rich in variety. Although initial studies concentrated on the behavior of industrial firms [3,4], today it is not uncommon to find studies of applications of the methodology of Feedback Dynamics on problems of the cities, the ecology, various social systems, and of the world. Initially Feedback Dynamics was known as Industrial Dynamics [9] because of the nature of its applications. This name had to be changed to Feedback Dynamics because of the many non-industrial applications that have been made since.

Several studies covering the dynamics of growth in corporations have been made at the Massachusetts Institute of Technology. Nord [17], looks at the interactions between the capacity-acquisition policy of the company and the market growth of the product. He shows how the capacity acquisition policy may suppress the growth rate, and how a different policy can achieve increased product growth. He points out that the consideration of price cutting when the company is faced with overcapacity would be interesting to explore.

Packer [18] examines how growth success depends on the way that production capacity--in the form of labor, machinery or plant space--and professional effort--engineering and managerial--are acquired and absorbed into the firm.

Forester [11] looks at the growth phenomena, focusing on the relationships of the marketing functions and policies, and the production and order generating sector.

Payette [19] extends the work of Nord and Packer by including a financial sector in the model, however, this study is limited to the consideration of the cash balance. In this model, cash balance has three flows: income from sale of the product, expenditures of production manpower, and expenditures of sales and technical manpower. He recommends the inclusion of debt as another source of funds for corporate growth, in the financial sector, as an extension of his work.

Several other authors have worked with models of corporations. Browne [3] built a model of a hypothetical company depicting, without a specific problem focus, some of the major functions that are essential to the firm's everyday business activities. This is a rather uncommon approach to feedback applications. This model does not consider debt as a source of capital for investments.

Burril [4] presents a computer model of a growth company including financial policies and actions such as external financing and price setting. However, his approach is not that of Feedback Dynamics and consequently limited understanding of the growth phenomena results from treating variables separately. Increased understanding of the system would be gained if the feedback loop concept of the Feedback Dynamics methodology were added to Burril's model. It would be advantageous and meaningful to look at financial policies including debt financing with the broader look that Feedback Dynamics facilitate.

CHAPTER III

OBJECTIVES AND APPROACH

A. Purposes and Objectives

The purpose of this research is to increase the understanding of the Feedback Dynamics philosophy and methodology. Its objectives are:

(1) To identify some important feedback loops that control the patterns of behavior of the corporation.

(2) To understand why these feedback loops cause the patterns of behavior of the firm.

(3) To apply the knowledge of Financial Decision Making and Feedback Dynamics in a common industrial system, through the use of a mathematical simulation model.

The scope of this thesis is limited to consideration of only a few selected factors affecting the growth behavior of an enterprise.

B. Approach

A general methodology for the development and execution of a Feedback Dynamics study is now presented. This methodology is based on the systems approach to solving problems and on experience gained in earlier Feedback Dynamics studies. It consists of the following steps:

(1) Description of the problem. Selection of the system's behavior patterns that represent the problem.

(2) Identification of the main variables and factors to be included. Definition of the boundaries that will contain the system.

(3) Identification of the information feedback loops responsible for the behavior patterns of the system.

(4) Construction of a flow diagram of the structure of the system.

(5) Construction of a mathematical model of the internal relationships of the system's structure.

(6) Simulation of the system, obtaining the behavior of the variables of interest through time.

(7) Comparison of the behavior observed in the simulation runs with the initial descriptors of the problem.

(8) Revision and modification of the model until the patterns of behavior, descriptors of the problem, are obtained, and the reasons for the patterns are understood.

(9) Creation of more desirable behavior patterns by redesigning policies or modifying the structure of the model.

(10) Implementation of the improved policies in the real system.

C. Nature of the Model

Several levels of detail can be identified in a Feedback Dynamics model:

(1) Single variables and parameters

(2) Information feedback loops

(3) Sectors

There are basically three types of variables in any model. These are:

(1) Accumulations: Usually represented by rectangles, they show the present value of variables that change through time under the influence of flows.

(2) Flows: Usually represented by val es, they show the rate at which changes in the accumulations are executed. Two types of flows exist, inflows are those that increase the level of the accumulation and outflows are those that decrease it.

(3) Auxiliaries: Usually represented by circles, they show modifications of information coming from accumulations and serve as a simplification of the flow equation.

Parameters appear in two forms:

(1) Initial values: These parameters define the value of the accumulations at the start of the simulation.

(2) Constants: Usually accompanying the formulation of auxiliaries and rates.

Information feedback loops usually include accumulations, flows and auxiliaries. A very simple feedback loop is shown in Figure 3.1.

This loop is constructed in such a way that if a difference exists between the value of the accumulation and

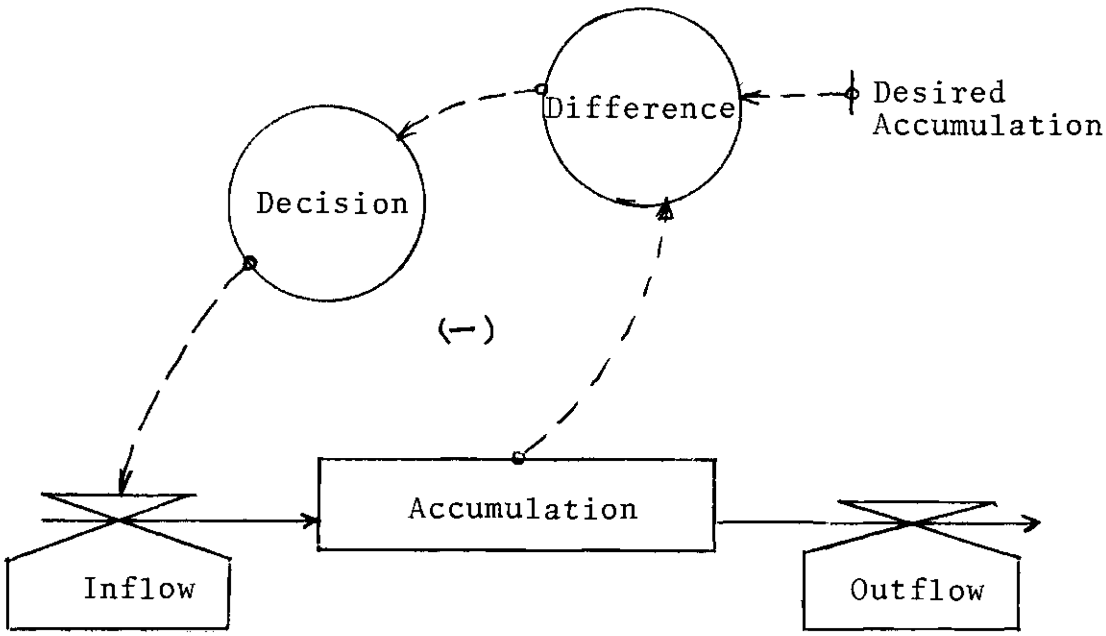


Figure 3.1. A Simple Negative Feedback Loop

its desired value or objective at a point in time, a decision is made to correct the discrepancy. The correction is made through a change in the rate of inflow. Continuous arrows indicate physical flow while spaced-line arrows indicate information transference.

Feedback loops may be either positive or negative. A positive feedback loop is characterized by a positive change in the value of the accumulation coming around the loop after an initial positive change in the accumulation was made. A negative feedback loop is illustrated in Figure 3.1. In this case, an initial positive change in the value of the accumulation causes a future decrease in the accumulation after the information has traveled around the loop.

Positive feedback loops are associated with growth, negative feedback loops are usually associated with oscillatory, goal-seeking behavior.

The third level of aggregation is the sector. A set of accumulations, flows and auxiliaries forming several loops that interact and that have a factor or concept in common, with which they can be identified, is called a sector of the model.

CHAPTER IV

DESCRIPTION OF THE PROBLEM

Many problems plague any corporation attempting to give the stockholders a fair return on their investment. Some of these problems arise as a consequence of external factors influencing the system. Many others are caused by the actions taking place within the system.

This study tries to identify and understand the cause of some of the latter kind of problems, those that are a direct consequence of the structure and actions of the system, however, particular attention is focused on one special sector in the system and on its relationships with some other relevant sectors.

There are two major issues that will be studied in this thesis. The first one consists of how fast the company reaches a level of production to satisfy its sales potential completely. The second is concerned with the effectiveness of the company during periods of fast growth in capacity, and when working with a limited demand afterwards.

The basic ideas for the development of the study came from an actual small company, manufacturing an industrial replacement part and serving the Mexican industry. It is believed that this company has long term growth potential because of the following facts:

(1) The company is marketing a product which was earlier being imported from several other countries. The Mexican Government has prohibited the importation of this product since the product is now available in the Mexican market.

(2) The company holds a patent that assures product uniqueness. However, competition exists with other manufacturers that produce substitute products.

(3) The Mexican industry is in constant need of this product. However, it takes many years for a company to develop and market a new substitute product because of its high technology design requirements. As a result, it is assumed that new competition will not enter the present market. This type of situation can be identified as monopolistic competition.

A graphic description of the actual situation of this company is shown in Figure 4.1.

Any company that is confronted with the type of market potential just observed, must create policies that direct its resources toward the creation of growth in a profitable manner.

Growth may take many alternative paths, but in all of them, two characteristics are important. Growth can be identified with the rate of growth and with the tendency for oscillation.

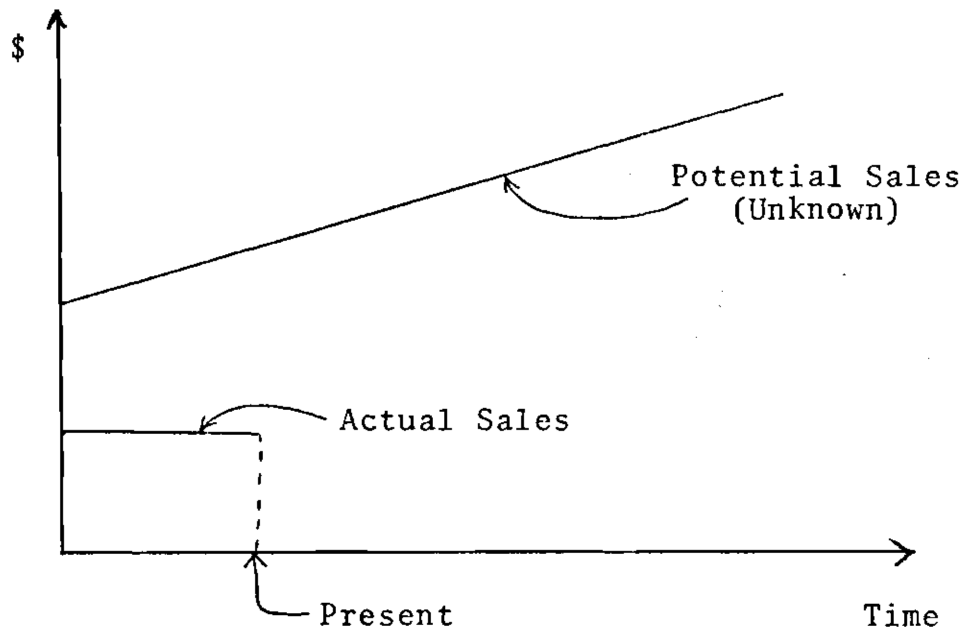


Figure 4.1. Actual Situation of Small Company

Examples of these alternative paths are illustrated in Figure 4.2.

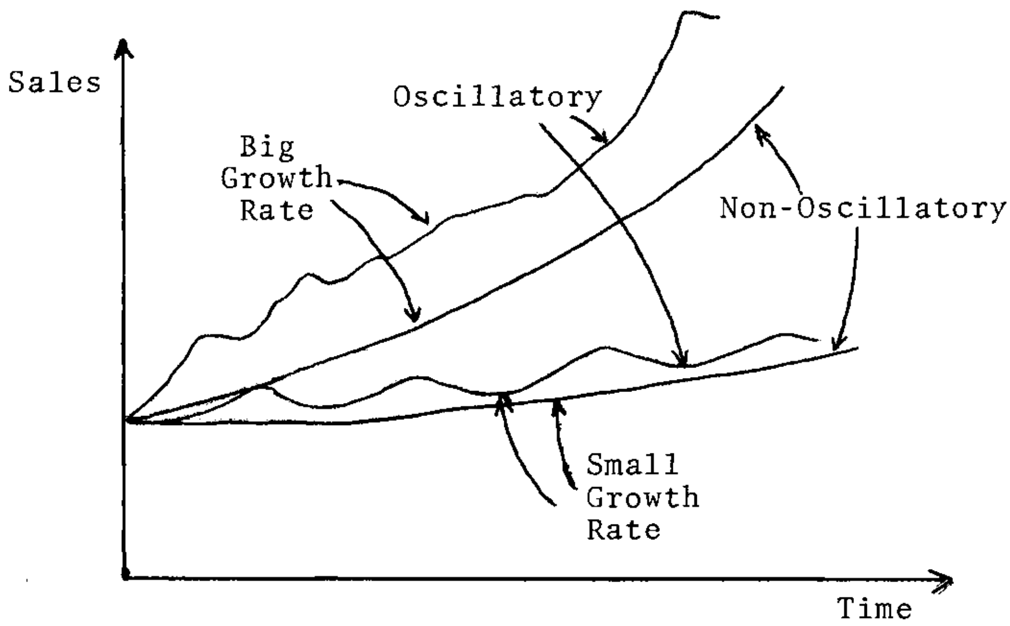
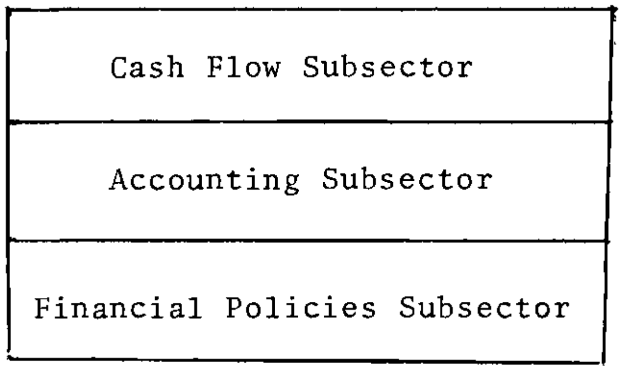


Figure 4.2. Alternative Growth Paths

Since this study is focused on the financial policies of corporations and on the corporate growth behavior that they cause, a model of a hypothetical company, consisting of three major sectors, was built. Many of the characteristics of this model were introduced to make its conditions equivalent to those of the small company mentioned before. This model is intended to help in the understanding of some selected financial policies. It will also serve to illustrate the kind of results that a company may have under different policies in the financial sector.

The three sectors and their main interactions are shown in a simple representation of the model in Figure 4.3.

The financial sector is divided in three subsectors for the purpose of clarification. These sector subdivisions will be helpful in the explanation of the model in Chapter V.



The financial policies subsector contains four policies: external financing, dividends, capacity investments and pricing. These will be explained in Chapter V. However the major feedback loops that contain these policies are presented in Figures 4.4, 4.5, 4.6, and 4.7.

It is hypothesized that the company's growth rate and growth effectiveness is significantly influenced by four major policies in the financial sector, namely the policy of investment in capacity, the policy of pricing, the policy of

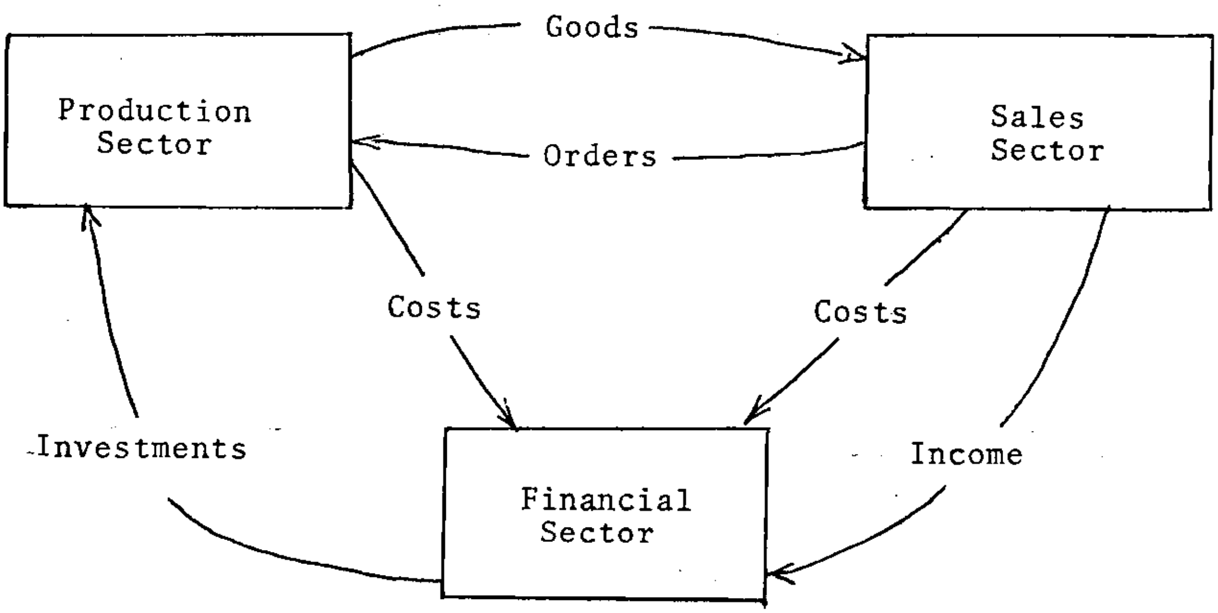


Figure 4.3. Three Sectors of the Model

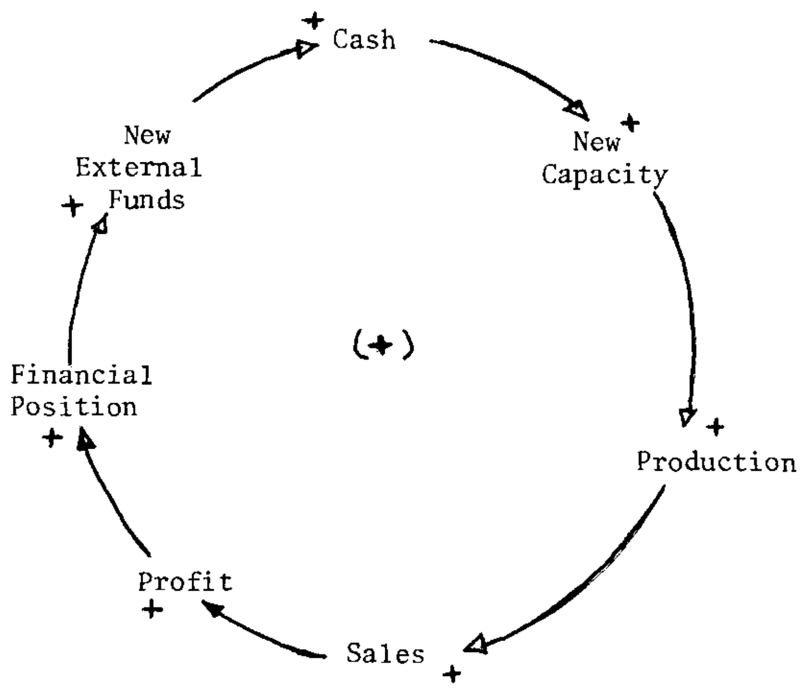


Figure 4.4. Positive Feedback Loop for the External Financing Policy

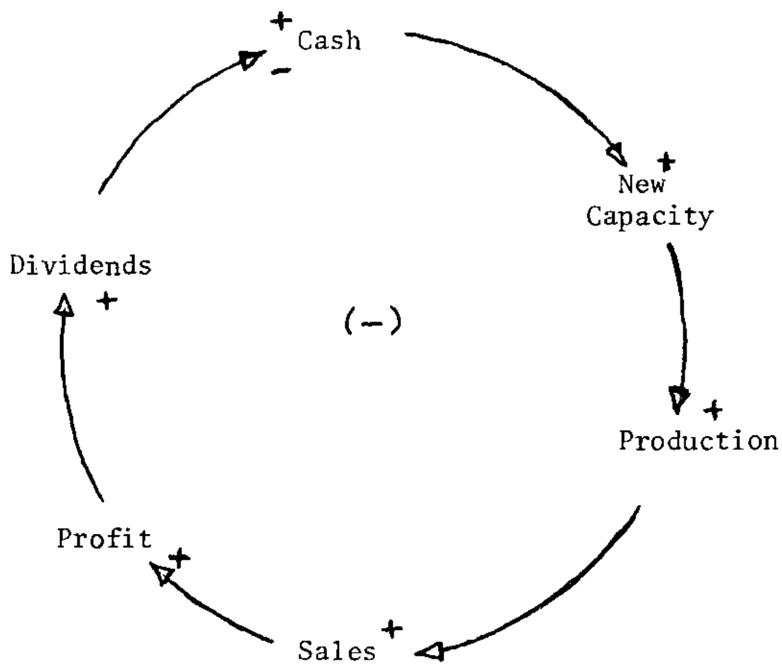


Figure 4.5. Negative Feedback Loop for the Dividend Policy

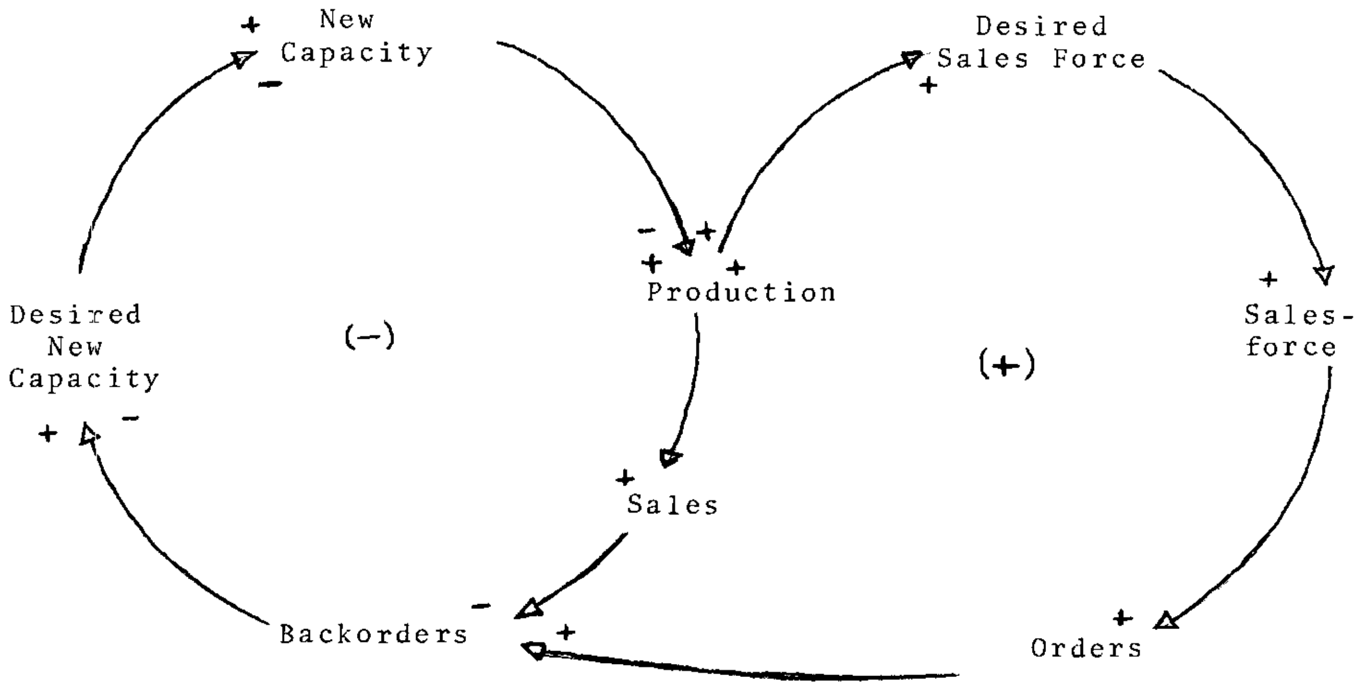


Figure 4.6. Positive and Negative Feedback Loops for the Capacity Investment Policy

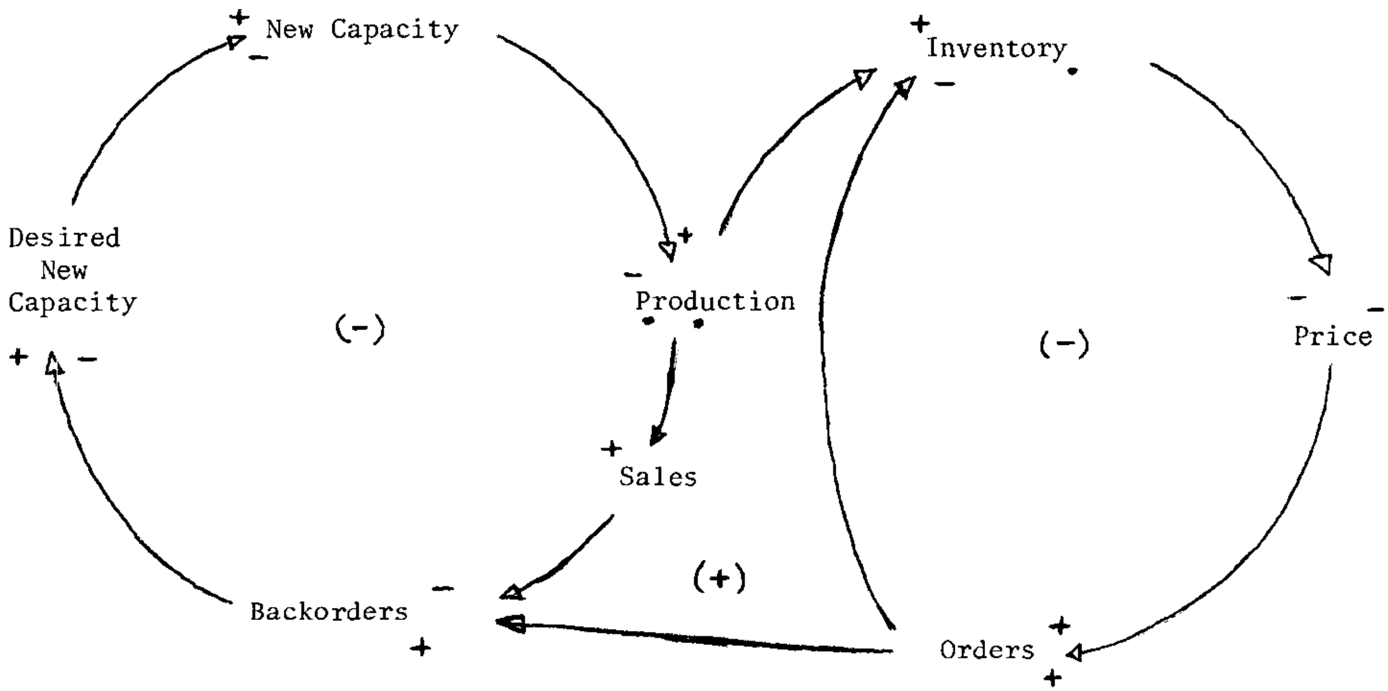


Figure 4.7. Negative and Positive Feedback Loops for the Pricing Policy

external financing and the policy of dividends.

The policy of investment in capacity will influence capacity and consequently production rate. This in turn sets the product availability which is needed for income and profit creation through the sale of the product. A fundamental isolated hypothesis here is that, other things being equal, bigger investments in capacity will bring bigger growth.

The policy of product pricing is also important in this study because the market is sensitive to price and has a particular way of reacting to changes in it. Orders are affected which in turn affect income and profit.

The policy of external financing will only consider long term debt financing. External financing is important because long term debt is a major source of capital for expansion. As with any other resource, long term debt should be wisely used to produce the most effective and greater growth. A fundamental hypothesis here is that external financing brings more funds to the company when they are needed and it is partially responsible for the growth rate of the corporation.

The dividend policy will also have an influence on the growth pattern of the company. Instead of paying dividends, the company may retain the earned money for plant expansion purposes. The hypothesis here is that the dividend policy is most critical in periods of fast company growth.

The expected behavior of some important variables, with the use of the financial policies stated in the next chapter is shown in Figure 4.8.

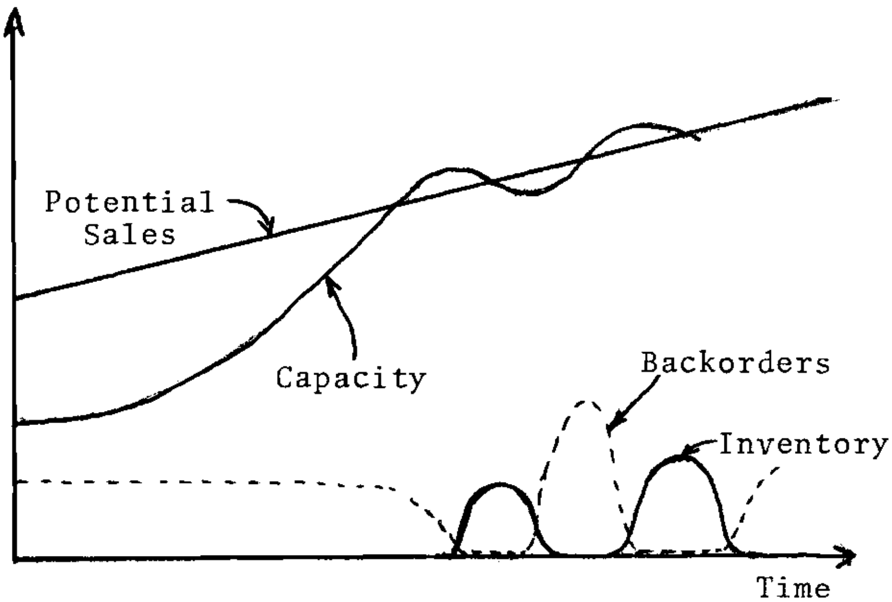


Figure 4.8. Expected Behavior of Important Variables

The assumptions made and the resemblance of the hypothetical company model to the actual small company are discussed in the next chapter.

CHAPTER V

STRUCTURE OF MODEL

A. Introduction

The construction of a model usually requires a well defined basis. The four financial policies and their interrelationships with themselves and with other relevant elements of a manufacturing system provide the basis for the development of the model of this chapter.

Many assumptions and simplifications had to be made in order to produce a model capable of reflecting the behavior of the main variables under the influence of the financial policies in a clear and understandable manner.

A model is usually constructed to serve one purpose and this one attempts to provide a means of understanding the effects of financial decision making on the growth behavior of corporations.

The model consists of many variables and feedback loops. The explanation will follow each sector and subsector to facilitate understanding. A complete flow diagram of the model is shown in Figure 5.1. Other diagrams will be presented in each of the sector sections. The mathematical equations for each sector are explained in this chapter. The listing of the complete original model equations can be

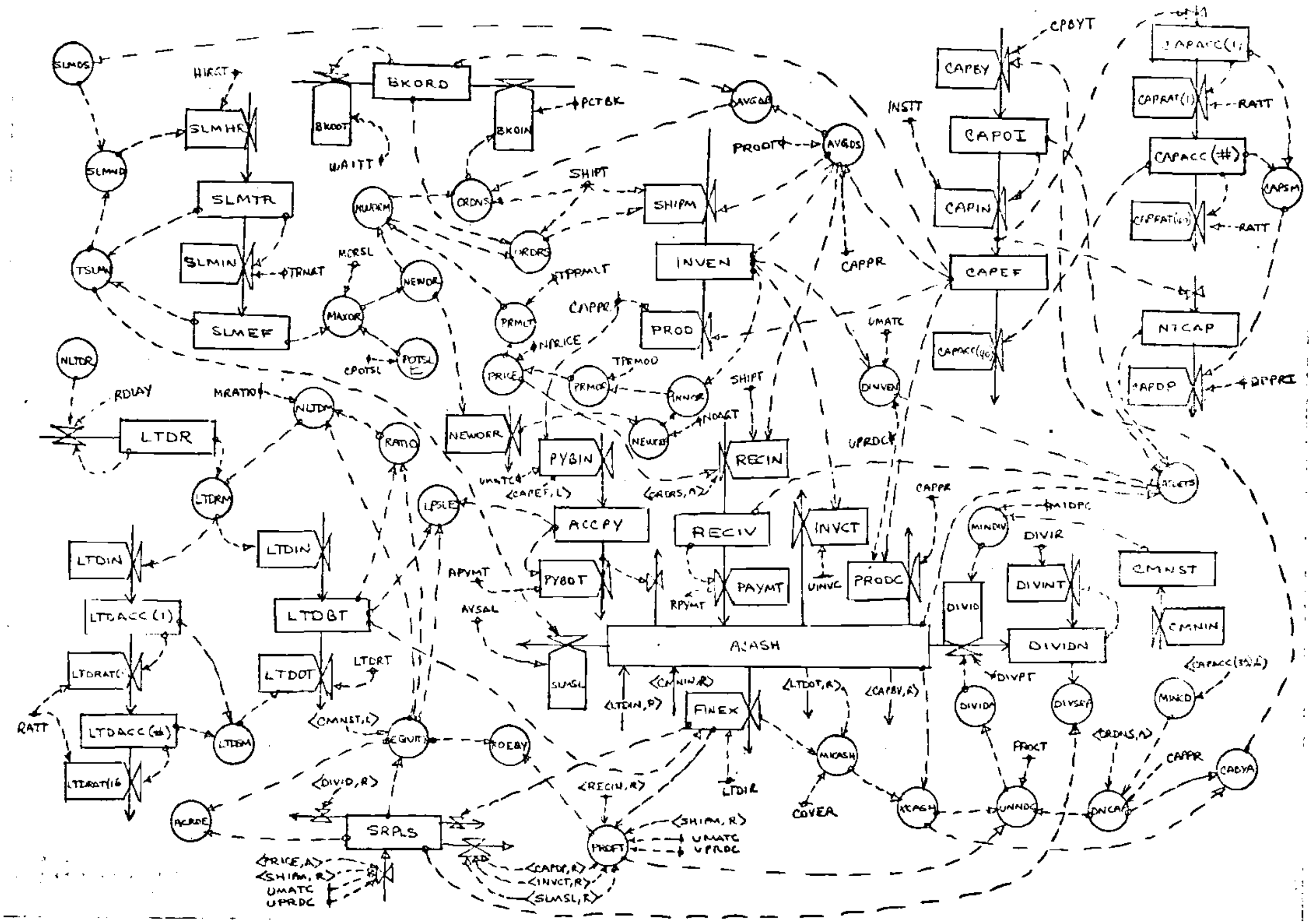


Figure 5.1. Complete Flow Diagram of the Model

found in Appendix A, and the meaning of the variables utilized in Appendix B.

The production sector will be presented first followed by the sales sector. The financial sector was subdivided and three subsectors will be presented. The cash flow subsector is followed by the accounting subsector and by the financial policies subsector.

B. Production Sector

A flow diagram of the production sector is shown in Figure 5.2.

The basis for the company's production capability is the plant capacity that it has installed. Two types of plant capacity exist in the model. The first one is the direct accumulation of newly acquired capacity that is undergoing a time period of installation. This is called capacity on installation.

```
L     CAPOI.K=CAPOI.J+(DT)(CAPBY.JK-CAPIN.JK)
N     CAPOI=CCAPOI
O     CCAPOI=62500
```

CAPOI	Capacity on installation ($)
CAPBY	Capacity buying rate ($/quarter)
CAPIN	New capacity installed ($/quarter)
CCAPOI	Initial capacity on installation ($)

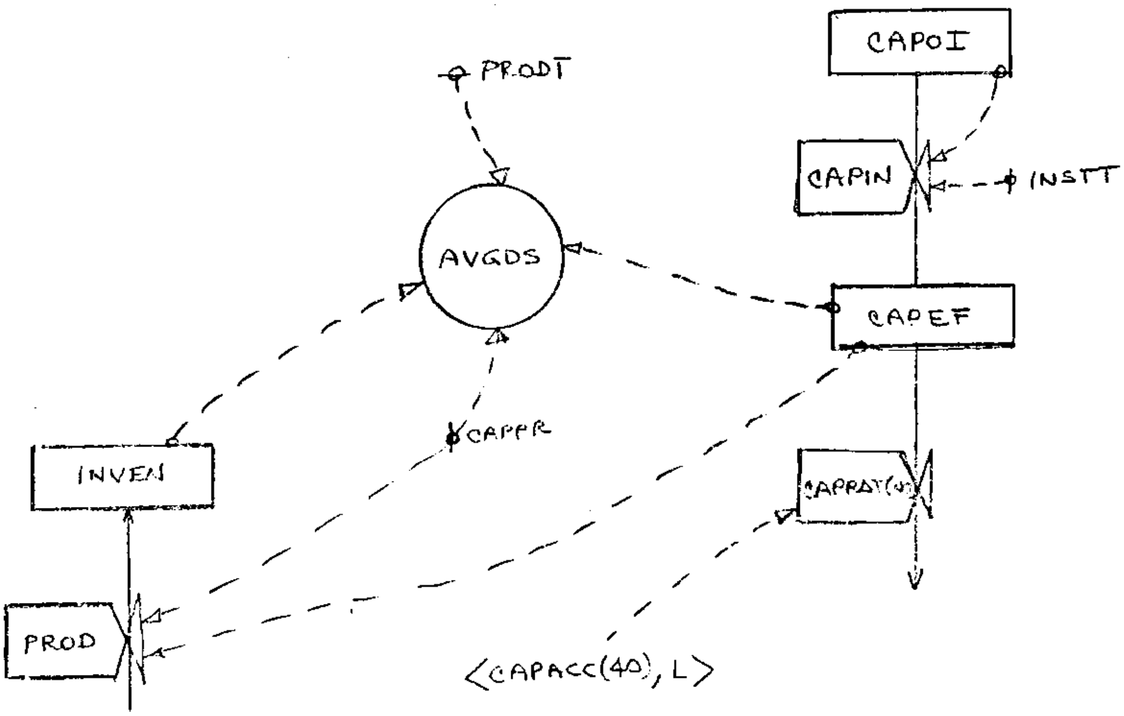


Figure 5.2. Flow Diagram of the Production Sector

After a period of time, the capacity on installation becomes effective and therefore ready for production purposes. The rate at which capacity becomes effective is called new capacity installed. The next equation states that all capacity being installed is ready for production after one quarter.

```
R  CAPIN.KL=CAPOI.K/INSTT
C  INSTT=1
```

CAPIN New capacity installed (\$/quarter)

CAPOI Capacity on installation (\$)

INSTT Installation time (quarters)

This accumulation of capacity is referred to as effective capacity.

```
L  CAPEF.K=CAPEF.J+(DT)(CAPIN.JK-CAPRAT.JK(40))
N  CAPEF=CCAPEF
C  CCAPEF=2500000
```

CAPEF Capacity effective (\$)

CAPIN New capacity installed (\$/quarter)

CAPRAT(40) Capacity rate of retirement after 40 quarters (\$/quarter)

CCAPEF Initial capacity effective (\$)

In this study it was assumed that plant capacity becomes ineffective after 40 quarters of use, and this is stated by the following equation.

R CAPRAT.KL(40)=CAPACC.K(40)/CAPAT

C CAPAT=1

CAPRAT(40)	Capacity rate of retirement after 40 quarters ($/quarter)
CAPACC(40)	Capacity accumulated with 40 quarters of service ($)
CAPAT	Capacity age time (quarters)

The meaning and uses of the last two array variables will be explained in the accounting subsector section of this chapter.

Once capacity is installed and effective it produces continuously for 40 periods. Production is standardized and each unit of capacity serves to produce a corresponding number of articles. Some companies adjust production to varying needs and resist periods of idle capacity. In this case the main concern is with the financial policies subsector of corporations and consequently the production function expressed below is stated in a simple way.

```
R     PROD.KL=(CAPEF.K)(CAPPR)
C     CAPPR=.02
```

PROD	Production rate (units/quarter)
CAPEF	Capacity effective ($)
CAPPR	Capacity productivity (units/quarter/$)

After one unit is produced, it is ready for sale. Sometimes not all the units produced are sold in the same period. When this occurs, the units will form the finished goods inventory while they are sold. The inventory accumulation equation is:

```
L     INVEN.K=INVEN.J+(DT)(PROD.JK-SHIPM.JK)
N     INVEN=CINVEN
C     CINVEN=0
```

INVEN	Inventory in units (units)
PROD	Production rate (units/quarter)
SHIPM	Shipment rate (units/quarter)
CINVEN	Initial value of inventory (units)

The shipment rate will be explained later in this chapter with the sales sector. However a physical limit can now be established that will help in the definition of the shipment rate. This limit will be defined as the expected available goods for sale.

A	AVGDS.K=INVEN.K+(CAPEF.K)(CAPPR)(PRODT)
C	CAPPR=0.2
C	PRODT=1

AVGDS	Expected available goods for sale (units)
INVEN	Inventory in units (units)
CAPEF	Capacity effective ($)
CAPPR	Capacity productivity (units/quarter/$)
PRODT	Production time (quarters)

C. Sales Sector

A flow diagram of the sales sector is shown in Figure 5.3.

There are several similarities between the production sector and the sales sector. In both cases, resources are acquired, set up and utilized for the sector purpose. In the sales sector the purpose is to generate orders for the shipment of the articles produced. In this case the resource utilized to achieve that purpose is people specially trained for that purpose.

Salesmen are hired for this purpose and the rate of hiring is:

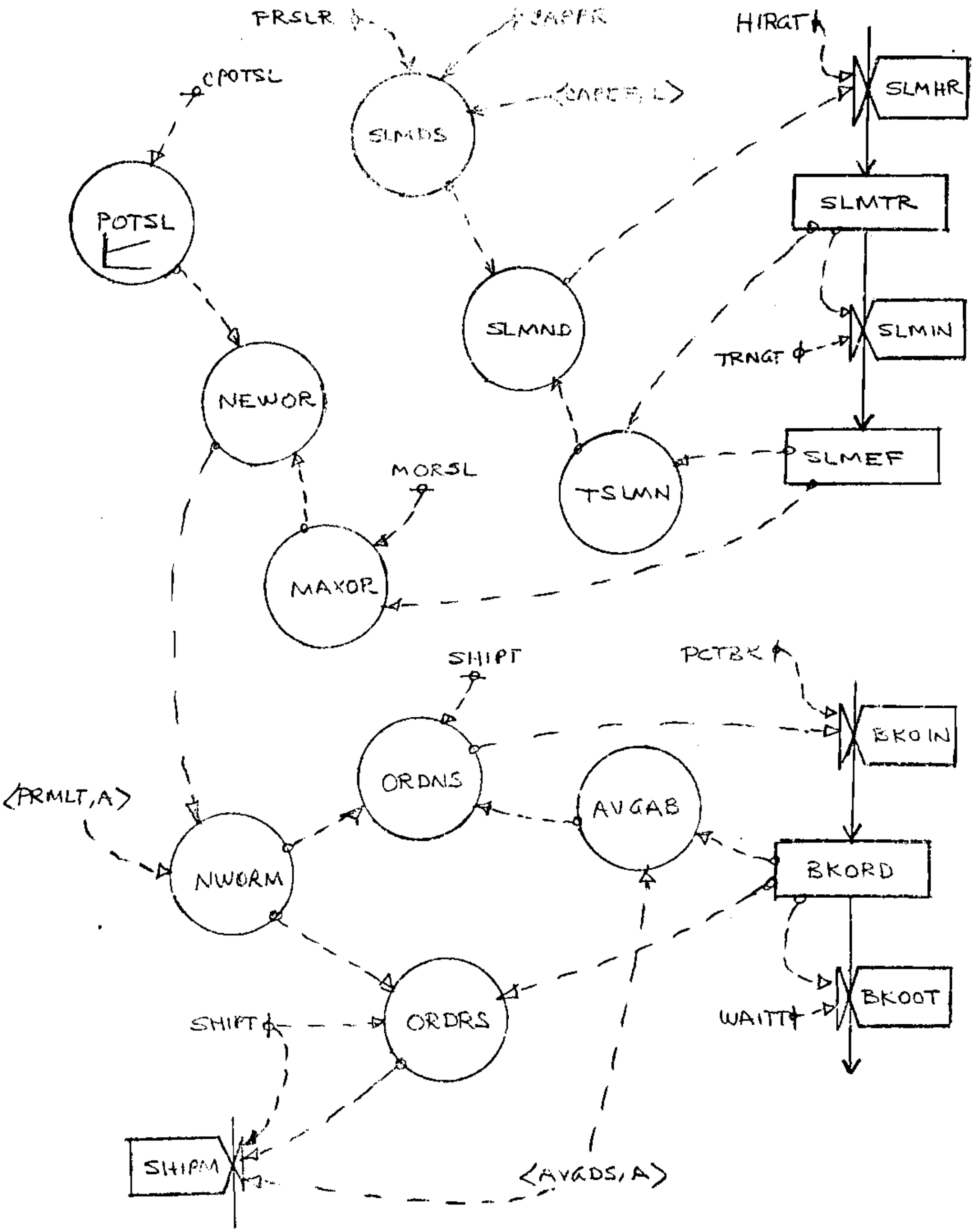


Figure 5.3. Flow Diagram of the Sales Sector

R SLMHR.KL=SLMND.K/HIRGT

C HIRGT=1

SLMHR	Salesmen hired (men/quarter)
SLMND	Salesmen needed (men)
HIRGT	Hiring correction time (quarters)

The past equation is completed by the definition of the following two auxiliary equations. Salesmen needed is defined by:

A SLMND.K=MAX(0,SLMDS.K-TSLMN.K)

SLMND	Salesmen needed (men)
SLMDS	Salesmen desired (men)
TSLMN	Total salesmen (men)
MAX	Dynamo maximizing function
0	Minimum possible value of salesmen needed (men)

The first link of the sales and the production sector is illustrated with the next equation for the policy of desired salesmen.

A	SLMDS.K=(CAPEF.K)(CAPPR)/PRSLR
C	CAPPR=.02
C	PRSLR=5000

CAPEF	Capacity effective ($)
SLMDS	Salesmen desired (men)
CAPPR	Capacity productivity (units/quarter/$)
PRSLR	Production to salesmen ratio (units/quarter/men)

The last equation describes a policy of management that may be interpreted as "it is desirable for the company to have one salesman for every 5000 units being produced." This policy is partially based on the knowledge of the average productivity of salesmen.

After defining the hiring policy, the two kinds of groups of salesmen are defined. The first one is composed of those people just hired by the company and that are under a training period.

L	SLMTR.K=SLMTR.J+(DT)(SLMHR.JK-SLMIN.JK)
N	SLMTR=CSLMTR
C	CSLMTR=0

SLMTR	Salesmen in training (men)
SLMHR	Salesmen hired (men/quarter)

SLMIN   Salesmen effective inflow (men/quarter)

CSLMTR   Initial value of salesmen in training (men)

As with capacity on installation, the rate of flow from salesmen in training to effective salesmen is equal to the number of salesmen in training. The equation that represents this flow is:

```
R    SLMIN.KL=SLMTR.K/TRNGT
C    TRNGT=1
```

SLMIN   Salesmen effective inflow (men/quarter)

SLMTR   Salesmen in training (men)

TRNGT   Training time (quarters)

This flow is the one that permanently increases the number of effective salesmen working for the company. It is assumed that no salesman leaves the company or is fired because of the growing need for them supported by the market growth assumption. Expressed in an equation this is:

```
L    SLMEF.K=SLMEF.J+(DT)(SLMIN.JK)
N    SLMEF=CSLMEF
C    CSLMEF=9.09
```

SLMEF   Salesmen effective (men)

SLMIN   Salesmen effective inflow (men/quarter)

CSLMEF   Initial value of salesmen effective (men)

To complete the work force part of this sales sector a definition of a variable for the number of salesmen in training and those already effective is necessary.

A   TSLMN.K=SLMTR.K+SLMEF.K

TSLMN   Total number of salesmen (men)

SLMTR   Salesmen in training (men)

SLMEF   Salesmen effective (men)

The second link between the production and the sales sector starts with the definition of the number of orders generated by the salesmen. This model assumes that expected orders, defined by the following equations, are equal to actual orders. It is also assumed that only effective salesmen generate orders and that the group's average generation rate is constant. These assumptions are presented in the next equation.

A   MAXOR.K=(SLMEF.K)(MORSL)

C   MORSL=5500

MAXOR	Maximum number of orders (units/quarter)
SLMEF	Salesmen effective (men)
MORSL	Average orders generated per salesman (units/man/quarter)

However the company may realize that the actual demand of the product is below the "maximum orders generated" value, and that in such a case a redefinition of orders has to be established. The next equation defines this relationship between orders, maximum orders and demand.

A NEWOR.K=MIN(POTSL.K,MAXOR.K)

NEWOR	New orders (units/quarter)
POTSL	Potential sales (units/quarter)
MAXOR	Maximum number of orders (units/quarter)
MIN	Minimizing function

The potential sales function used in this simulation is now presented. In Chapter IV it was established that the hypothetical company had an initial unsatisfied demand and that this unsatisfied demand was going to be reduced by the expansion of the company. With those characteristics in mind it was assumed that the market is demanding 100,000 units at the start of the simulation and that this demand will grow steadily 1000 units each quarter. The equation that describes the potential sales is:

A POTSL.K=CPOTSL+RAMP(1000,0)

C CPOTSL=100000

POTSL	Potential sales (units/quarter)
CPOTSL	Initial value of potential sales (units/quarter)
RAMP	Dynamo input function

A further modification of the orders equation becomes inevitable after knowing that the price of the article may be variable and consequently the potential sales and the productivity of the salesmen too. It is assumed that both potential sales and productivity of salesmen are equally affected. This leads to a modified definition of new orders.

A NWORM.K=(NEWOR.K)(PRMLT.K)

NWORM	New Orders modified (units/quarter)
NEWOR	New orders (units/quarter)
PRMLT	Price multiplier on orders (dimensionless)

In order to correctly express the number of orders outstanding in any period, consideration should be given to those orders that have remained unsatisfied. Therefore a complete equation for orders is:

A   ORDRS.K=BKORD.K/SHIPT+NWORM.K

ORDRS	Orders (units/quarter)
BKORD	Backorders (units)
NWORM	New orders modified (units/quarter)

In the production sector, one limit for the number of shipments was introduced. This availability of goods limit along with the number of orders are used in the definition of product shipments. The quantity shipped each quarter will be equal to the number of expected orders if there are enough goods for sale, or the number of expected units for sale otherwise.

R   SHIPM.KL=MIN(ORDRS.K,AVGDS.K/SHIPT)

C   SHIPT=1

SHIPM	Product shipments (units/quarter)
ORDRS	Expected total number of orders (units/quarter)
AVGDS	Expected available goods for sale (units)
SHIPT	Shipment time (quarters)
MIN	Dynamo minimizing function

Backorders are those orders from a past period that were not satisfied because of insufficient goods for sale, and that remain in a backlog which will be satisfied in the next period.

L BKORD.K=BKORD.J+(DT)(BKOIN.JK-BKOOT.JK)

N BKORD=CBKORD

C CBKORD=0

BKORD	Backorders (units)
BKOIN	Backorders inflow (units/quarter)
BKOOT	Backorders outflow (units/quarter)
CBKORD	Initial value of backorders (units)

The model assumes that only certain percent of the customers are willing to wait an extra period for the shipment of their orders. It also assumes that no customer is willing to wait more than one extra period for the satisfaction of his order. The first assumption is written in the following equation.

R BKOIN.KL=(ORDNS.K)(PCTBK)

C PCTBK=.5

BKOIN	Backorders inflow (units/quarter)
ORDNS	Orders not satisfied in the last period (units/quarter)
PCTBK	Percent of market that allows backordering

The second assumption is expressed by the next equation

R BKOOT.KL=BKORD.K/WAITT

C WAITT=1

BKOOT	Backorders outflow (units/quarter)
BKORD	Backorders (units)
WAITT	Waiting time (quarters)

The shipment priority policy is clearly written in the next equation that defines available goods after back-orders are serviced. This policy states that the backorders will always be serviced before any new order.

A AVGAB.K=MAX(0,AVGDS.K-BKORD.K)

AVGAB	Expected available goods for sale after backorders (units)
AVGDS	Expected available goods for sale (units)
BKORD	Backorders (units)
MAX	Maximizing function
0	Minimum value of AVGAB

New orders not shipped in any period can now be expressed by the next equation.

A ORDNS.K=MAX(0,NWORM.K-AVGAB.K/SHIPT)

ORDNS	Orders not shipped last period (units/quarter)
NWORM	New orders modified (units/quarter)
AVGAB	Expected available goods for sale after backorders (units)
MAX	Maximizing function
0	Minimum number of orders not shipped last period (units)

D. Cash Flow Subsector

In this section of the model all cash flows from normal operations will be explained. A flow diagram of the cash flow sector is shown in Figure 5.4.

Production operations are responsible for some of the cash outflows. Raw materials are easily and rapidly acquired from several sources and it is assumed that its cost is only a function of the production rate and a constant price paid for each unit of them. Payment of raw materials utilized is not made immediately. A raw material account is created that has been called accounts payable. The equation describing the accumulation of raw material cost is:

L ACCPT.K=ACCPY.K+(DT)(PYBIN.JK-PYBOT.JK)

N ACCPY=CACCPY

C CACCPY=25000

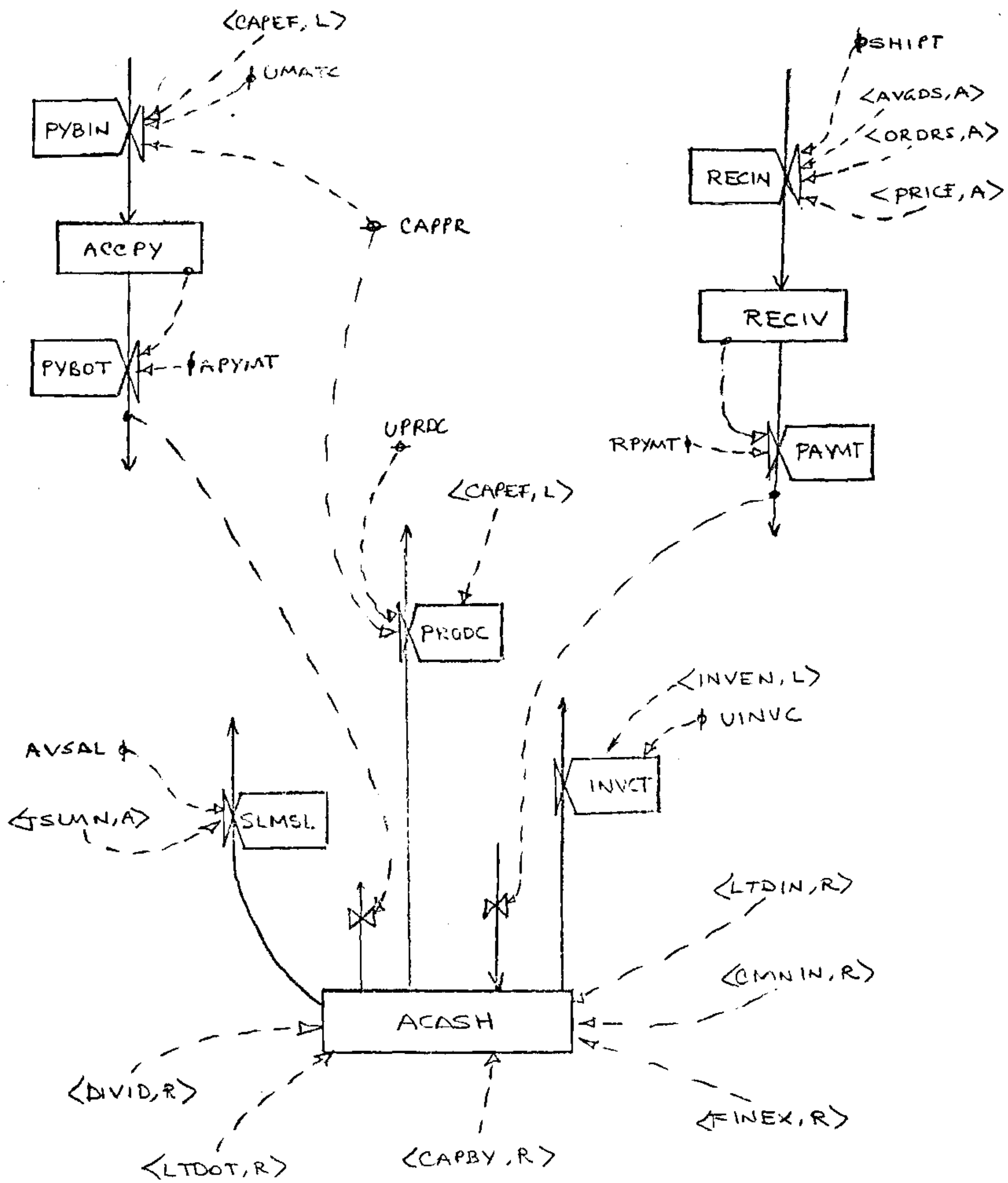


Figure 5.4. Flow Diagram of the Cash Flow Sector

ACCPY	Accounts payable ($)
PYBIN	Accounts payable inflow ($/quarter)
PYBOT	Accounts payable outflow ($/quarter)
CACCPY	Initial value of accounts payable ($)

The accounts payable inflow is a direct function of the production rate and the unit raw material cost.

```
R     PYBIN.KL=(CAPEF.K)(CAPPR)(UMATC)
C     CAPPR=.02
C     UMATC=.5
```

PYBIN	Accounts payable inflow ($/quarter)
CAPEF	Capacity effective ($)
CAPPR	Capacity productivity (units/quarter/$)
UMATC	Unit raw material cost ($/unit)

Observe that in this cost equation, production rate is not directly written but its definition, (CAPEF.K)(CAPPR), is.

Raw materials are paid one quarter after they were utilized in production. This payment creates a cash outflow that can be observed in the cash equation which is defined later in this section. The rate at which accounts payable are paid is:

R PYBOT.KL=ACCPY.K/APYMT

C APYMT=1

PYBOT	Accounts payable outflow ($/quarter)
ACCPY	Accounts payable ($)
APYMT	Accounts payable payment time (quarters)

The second cash outflow attributable to production operations is that of direct production cost. This cost includes labor and utilities. Non-direct production and administrative costs are a function of plant capacity, but since production rate is always a linear function of plant capacity, all these non-direct costs are aggregated and included under production costs. The equation for all of these costs is:

R PRODC.KL=(CAPEF.K)(CAPPR)(UPRDC)

C CAPPR=.02

C UPRDC=.5

PRODC	Production costs ($/quarter)
CAPEF	Capacity effective ($)
CAPPR	Capacity productivity (units/quarter/$)
UPRDC	Unit production cost ($/unit)

Inventories are responsible for a special cost that is a function of their size.

R INVCT.KL=(INVEN.K)(UINVC)

C UINVC=.25

INVCT	Inventory cost ($/quarter)
INVEN	Inventory of finished goods (units)
UINVC	Unit inventory cost ($/unit/quarter)

The sales sector generates two cash flows, one positive and one negative. The negative flow or outflow is a direct function of the total number of salesmen working for the company. Total salesmen salaries are expressed in the following equation.

R SLMSL.KL=(TSLMN.K)(AVSAL)

C AVSAL=2500

SLMSL	Salesmen salaries ($/quarter)
TSLMN	Total Salesmen (men)
AVSAL	Average salesmen salary ($/man/quarter)

The positive flow of inflow is caused by the sales of the product. However cash is only received after one quarter. An accumulation is created for this one quarter delay. This accumulation is defined below as accounts receivable.

```
L      RECIV.K=RECIV.J+(DT)(RECIN.JK-PAYMT.JK)
N      RECIV=CRECIV
C      CRECIV=200000
```

RECIV	Accounts receivable ($)
RECIN	Accounts receivable inflow ($/quarter)
PAYMT	Accounts receivable payments ($/quarter)
CRECIV	Initial value of accounts receivable ($)

The accounts receivable inflow is simply the quantity sold or shipments made multiplied by the current price of the product.

```
R      RECIN.KL=(MIN(ORDRS.K,AVGDS.K/SHIPT))(PRICE.K)
C      SHIPT=1
```

RECIN	Accounts receivable inflow ($/quarter)
ORDRS	Orders (units/quarter)
AVGDS	Expected available goods for sale (units)
SHIPT	Shipment time (quarters)
PRICE	Products' price ($)
MIN	Dynamo minimizing function

Remember that shipments were defined as the minimum of orders and available goods in the last section.

After one quarter, accounts receivable are paid and finally cash is received from the sales of the product. This means that the model assumes that no bad debts occur and that all shipments are paid in 90 days.

```
R     PAYMT.KL=RECIV.K/RPYMT
C     RPYMT=1
```

PAYMT	Accounts receivable payments ($/quarter)
RECIV	Accounts receivable ($)
RPYMT	Accounts receivable payment time (quarters)

Even though not all the cash flows have been defined so far, the equation representing the accumulation of cash will now be presented. Those terms in the equation that have not yet been defined will be found in the financial policies subsector section of this chapter.

```
L     ACASH.K=ACASH.J+(DT)(PAYMT.JK+LTDIN.JK+CMNIN.JK-PYBOT.JK
      -LTDOT.JK-CAPBY.JK-PRODC.JK-SLMSL.JK-FINEX.JK-INVCT.JK
      -DIVID.JK)
N     ACASH=CACASH
C     CACASH=126500
```

ACASH	Available cash ($)
PAYMT	Accounts receivable payments ($/quarter)
LTDIN	Long term debt inflow ($/quarter)
CMNIN	Common stock inflow ($/quarter)
PYBOT	Accounts payable outflow ($/quarter)
LTDOT	Long term debt outflow ($/quarter)
CAPBY	Capacity buying rate ($/quarter)
PRODC	Production costs ($/quarter)
SLMSL	Salesmen salaries ($/quarter)
FINEX	Financial expenditures ($/quarter)
INVCT	Inventory costs ($/quarter)
DIVID	Dividends ($/quarter)
CACASH	Initial value of available cash ($)

E. Accounting Subsector

In this section all the variables that are of an accounting nature and have not been presented before will be explained. A flow diagram of the accounting subsector is shown in Figure 5.5.

It may be helpful for the reader to have an idea of what a balance sheet and an income statement of the hypothetical company may look like. With this in mind, examplifying balance sheets and income statements are shown in Figures 5.6 and 5.7. Those in the right side are in common accounting terms, and those in the left are in the model's terms.

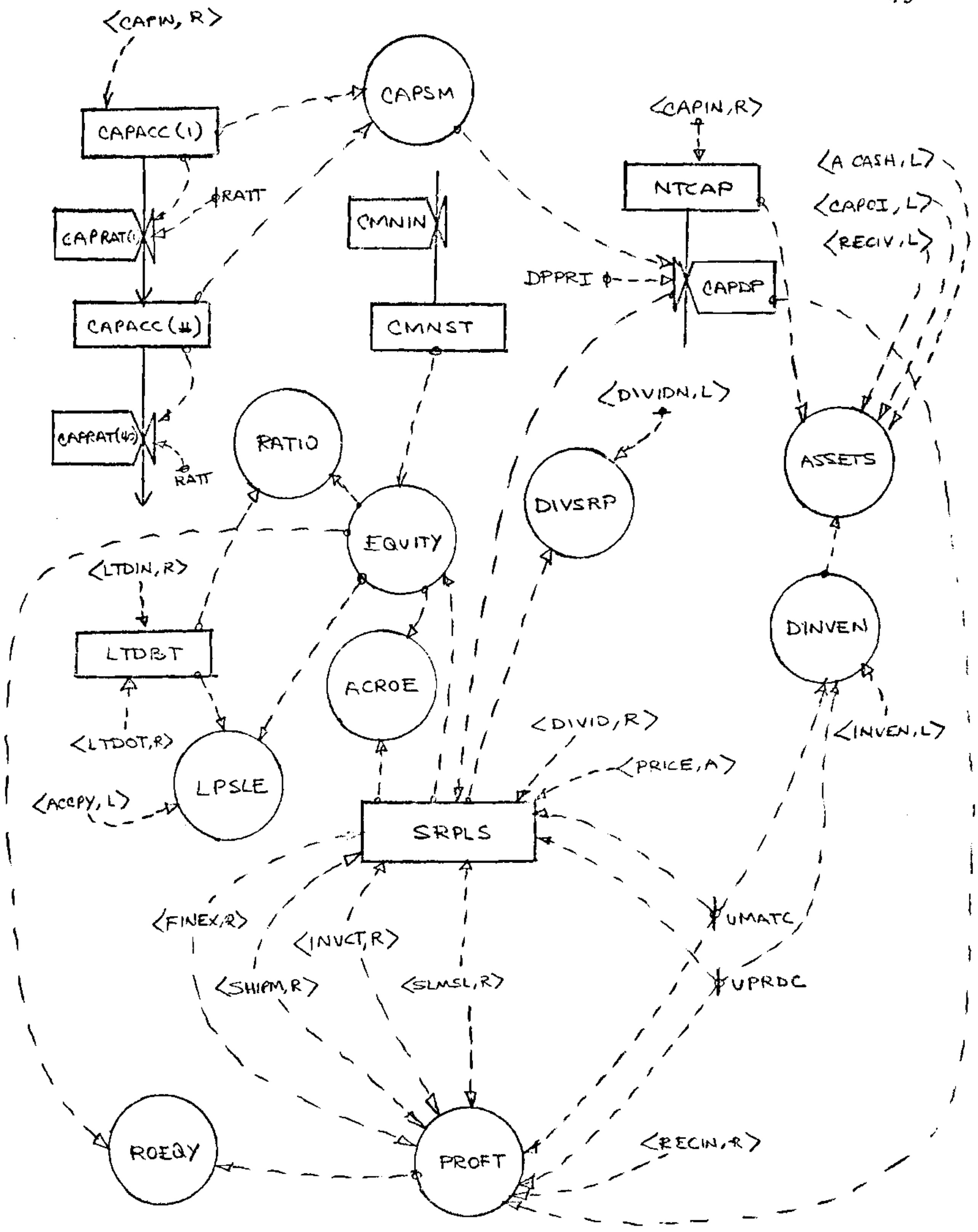


Figure 5.5. Flow Diagram of the Accounting Sector

ASSETS	2887500		
CASH	126500	ACASH	126500
ACCOUNTS RECEIVABLE	200000	RECIV	200000
INVENTORY	0	INVEN	0
PLANT CAPACITY	2562500	CAPOI	62500
		NTCAP	2500000
LIABILITIES	575000		
ACCOUNTS PAYABLE	25000	ACCPY	25000
LONG TERM DEBT	500000	LTDBT	500000
CAPITAL	2364000	EQUITY	2364000
COMMON STOCK	2364000	CMNST	2364000
SURPLUS	0	SRPLS	0

Figure 5.6. Balance Sheet

SALES INCOME	200000	RECIN	200000
-RAW MATERIALS	25000	-(SHIPM)(UMATC)	25000
-PRODUCTION COSTS	25000	-(SHIPM)(UPRDC)	25000
-PLANT DEPRECIATION	62500	-CAPDP	62500
OPERATING PROFIT	87500		87500
-SALESMEN SALARIES	25000	-SLMSL	25000
-INVENTORY EXPENSES	0	INVCT	0
-FINANCIAL EXPENSES	7500	-FINEX	7500
NET PROFIT	55000	PROFT	55000

Figure 5.7. Income Statement

Observe that this model does not consider taxes. This has been a necessary simplification for this research.

The first element of the Balance Sheet that has not yet been explained is DINVEN. This is just the finished goods inventory at cost expressed in monetary units.

```
A     DINVEN.K=(INVEN.K)(UPRDC+UMATC)
C     UPRDC=.5
C     UMATC=.5
```

DINVEN	Inventory expressed in dollars ($)
INVEN	Inventory in units (units)
UPRDC	Unit production costs ($/unit)
UMATC	Unit material cost ($/unit)

The next undefined element is NTCAP. This is a normal accounting accumulation that keeps the record of the book value capacity. Increases are made by new capacity installed and decreases are equal to depreciation charges.

```
L     NTCAP.K=NTCAP.J+(DT)(CAPIN.JK-CAPDP.JK)
N     NTCAP=CCAPEF
C     CCAPEF=2500000
```

NTCAP	Net capacity account ($)
CAPIN	Capacity effective inflow ($/quarter)

CAPDP	Capacity depreciation charge ($/quarter)
CCAPEF	Initial value of net and effective capacity ($)

On the liabilities side of the balance sheet, the first undefined element is LTDBT. This is an accumulation of long term debt whose flows will be explained in the financial policies subsector section. At this point interest is only on its accounting use.

```
L    LTDBT.K=LTDBT.J+(DT)(LTDIN.JK-LTDOT.JK)
N    LTDBT=CLTDBT
C    LTDBT =500000
```

LTDBT	Long term debt ($)
LTDIN	Long term debt inflow ($/quarter)
LTDOT	Long term debt outflow ($/quarter)
CLTDBT	Initial value of long term debt ($)

Stockholder's equity is the sum of the common stock and the surplus. This auxiliary equation is used in the financial policies subsector.

```
A    EQUITY.K=CMNST.K+SRPLS.K
```

EQUITY	Stockholders equity ($)
CMNST	Common stock ($)
SRPLS	Retained earnings or surplus ($)

Common stock is represented as a level equation. However the model assumes that no increases in common stock are made during the simulation period, or in other words, that new stock will not be a source of funds for the company during this period.

```
L    CMNST.K=CMNST.J+(DT)(CMNIN.JK)
N    CMNST=CCMNST
C    CCMNST=2364000
```

CMNST	Common stock ($)
CMNIN	Common stock inflow ($/quarter)
CCMNST	Initial value of common stock ($)

The accompanying flow equation is written here just for clarification.

```
R    CMNIN.KL=0
```

CMNIN   Common Stock inflow ($/quarter)

Surplus or retained earnings is the accumulation of net profit that the company decides to keep for new investment purposes. Discussion of its flows will be presented in the financial policies subsector section.

```
L     SRPLS.K=SRPLS.J+(DT)((SHIPM.JK)(PRICE.J-UPRDC-UMATC)-
      CAPDP.JK-SLMSL.JK-INVCT.JK-FINEX.JK-DIVID.JK)
N     SRPLS=CSRPLS
C     CSRPLS=0
```

SRPLS	Surplus ($)
SHIPM	Shipments (units/quarter)
PRICE	Product's price ($)
UPRDC	Unit production costs ($/unit)
UMATC	Unit material costs ($/unit)
CAPDP	Capacity depreciation charge ($/quarter)
SLMSL	Salesmen salaries ($/quarter)
INVCT	Inventory costs ($/quarter)
FINEX	Financial expenditures ($/quarter)
DIVID	Dividends ($/quarter)
CSRPLS	Initial surplus ($)

On the Income Statement only two terms have not been defined yet. The first one is the representation of the plant depreciation charge for the period. This is called capacity depreciation. A depreciable period of 40 quarters is used. The equation describing the depreciation charge is a function of capacity with service life of less than 40 quarters.

R CAPDP.KL=(CAPSM.K)(DPRRI)

C DPRRI=.025

CAPDP	Capacity depreciation charge ($/quarter)
CAPSM	Capacity with less than 41 quarters sum ($)
DPRRI	Depreciation period inverse (1/quarter)

In order to keep a record of the capacity with less than 41 quarters of service, three array equations were added. The first one contains capacity with one quarter of service.

L CAPACC.K(1)=CAPACC.J(1)+(DT)(CAPIN.JK-CAPRAT.JK(1))

N CAPACC(1)=CCAPEF/40

C CCAPEF=2500000

CAPACC(1)	Capacity with one quarter of service ($)
CAPIN	Capacity effective inflow ($/quarter)
CAPRAT(1)	Capacity starting second quarter of service ($/quarter)
CCAPEF/40	Initial value of capacity with one quarter of service ($)

The second contains capacity with CAPPR2 quarters of service, where CAPPR2 is an index variable varying from 2 to 40. This means that the following equation represents 39 simple equations.

```
L     CAPACC.K(CAPPR2)=CAPACC.J(CAPPR2)+(DT)(CAPRAT.JK(CAPPR2-1)
      -CAPRAT.JK(CAPPR2))
N     CAPACC=CCAPEF/40
C     CCAPEF=2500000
```

CAPACC(CAPPR2)	Capacity with CAPPR2 quarters of service ($)
CAPRAT(CAPPR2-1)	Capacity starting CAPPR2 quarters of service ($/quarter)
CAPRAT(CAPPR2)	Capacity starting CAPPR2+1 quarters of service ($/quarter)
CCAPEF/40	Initial value of CAPACC(CAPPR2) ($)

The flows in these equations are given by the following equation:

```
R     CAPRAT.KL(CAPPER)=CAPACC.K(CAPPER)/CAPAT
C     CAPAT=1
```

CAPRAT(CAPPER)	Capacity starting CAPPER+1 quarters of service ($/quarter)

CAPACC(CAPPER)	Capacity with CAPPER quarters of service ($)
CAPAT	Capacity age time (quarters)

Since it is necessary to have information of the total capacity being depreciated, the next equation adds all the contents of the array accumulations presented before, in a variable called capacity sum.

A CAPSM.K=SUMV(CAPACC.K,1,40)

CAPSM	Capacity sum ($)
CAPACC	Capacity with N quarters of service ($)
1,40	Internal values of N
SUMV	Dynamo addition function

Finally the equation representing net profit is presented. This equation is the simple addition of the other Income Statement terms.

A PROFT.K=(RECIN.JK-(SHIPM.JK)(UPRDC+UMATC)-CAPDP.JK-INVCT.JK-SLMSL.JK-FINEX.JK)

C UPRDC=.5

C UMATC=.5

PROFT	Net profit ($/quarter)
RECIN	Accounts receivable inflow ($/quarter)
SHIPM	Shipments of product (units/quarter)
UPRDC	Unit production cost ($/unit)
UMATC	Unit material costs ($/unit)
CAPDP	Capacity depreciation charge ($/quarter)
INVCT	Inventory costs ($/quarter)
SLMSL	Salesmen salaries ($/quarter)
FINEX	Financial Expenditures ($/quarter)

Observe that the equation for financial expenditures is defined in the financial policies subsector section.

Some other equations were added to the model to provide information which was helpful in the analysis of the behavior and the evaluation of improved policies. Knowledge of the total investment can be obtained either through the addition of the assets accounts or the liabilities and equity accounts. First, assets are added in the next equation to obtain their total.

A ASSETS.K=ACASH.K+RECIV.K+DINVEN.K+CAPOI.K+NTCAP.K

ASSETS	Total assets ($)
ACASH	Available cash ($)

RECIV	Accounts receivable ($)
DINVEN	Inventory in dollar terms ($)
CAPOI	Capacity on installation ($)
NTCAP	Net capacity account ($)

Liabilities and equity are added too.

A LPLSE.K=ACCPY.K+LTDBT.K+CMNST.K+SRPLS.K

LPSLE	Liabilities plus equity ($)
ACCPY	Accounts payable ($)
LTDBT	Long term debt ($)
CMNST	Common stock ($)
SRPLS	Surplus ($)

Various financial ratios were also included in the model to investigate new policies and to obtain more concrete information. One ratio which is used in financial decision making is the debt-equity ratio which in this model is simply called ratio.

A RATIO.K=LTDBT.K/EQUITY.K

RATIO	Long term debt to equity ratio
LTDBT	Long term debt ($)
EQUITY	Stockholder's equity ($)

Information as to the profitability of operations is also useful and the following ratio measures the return on stockholders equity.

A ROEQY.K=PROFT.K/EQUITY.K

ROEQY	Return on equity (%/quarter)
PROFT	New profit ($/quarter)
EQUITY	Stockholders equity ($)

Interesting too is the accumulated return on equity which is obtained by dividing accumulated surplus and equity.

A ACROE.K=SRPLS.K/EQUITY.K

ACROE	Accumulated return on equity
SRPLS	Surplus ($)
EQUITY	Stockholders equity ($)

Although the dividends accumulation has not been defined yet, the following accumulation representing total of dividends paid plus interest and surplus is very useful in the evaluation of alternative financial policies.

A DIVSRP.K=DIVIDN.K+SRPLS.K

DIVSRP	Dividends plus interest plus surplus ($)
DIVIDN	Dividends plus interest ($)
SRPLS	Surplus ($)

F. Financial Policies Subsector

A flow diagram of the financial policies subsector is shown in Figure 5.8.

The financial policies subsector contains equations for four major financial policies that are the center of attention of this research. These four major policies are:

(1) The capacity investment policy

(2) The pricing policy

(3) The external financing policy

(4) The dividend policy

These policies along with the policy of hiring salesmen have been the main interest of this research. In this section those policies that were causing the observed behavior are discussed. The objective is to understand what policy is causing what part of the model's behavior.

The capacity investment policy will be presented first, since the company is reasonably sure that it is servicing an expanding market, a policy has been established such that in each quarter there is a minimum desired new capacity, which is equal to the amount of effective capacity that will become ineffective after the end of the next period. The model assumes that capacity is effective only during 40 quarters, and that it is totally unusable and valueless afterwards. The minimum new capacity desired will be:

A MINCD.K=CAPACC.K(39)

MINCD	Minimum capacity desired ($)
CAPACC(39)	Capacity with 39 quarters of service ($)

Observe that the value of "capacity with 39 quarters of service" is used because of the one quarter delay involved in installing new capacity. In this case, new capacity will become effective at the same time that its corresponding effective capacity becomes ineffective.

Management is also aware of the occasional insufficiency of goods available to meet actual demand. Minimum desired capacity is not enough to meet insufficiency of goods available, and a new term of capacity expansion is introduced. A new expression for total desired new capacity is shown in the next equation. This equation includes a term for minimum desired new capacity, and another term which considers the lack of enough goods for sale. This second term is simply the number of new orders that remained in the backlog multiplied by the capacity to production ratio. The second term represents the new capacity necessary to meet unserved orders.

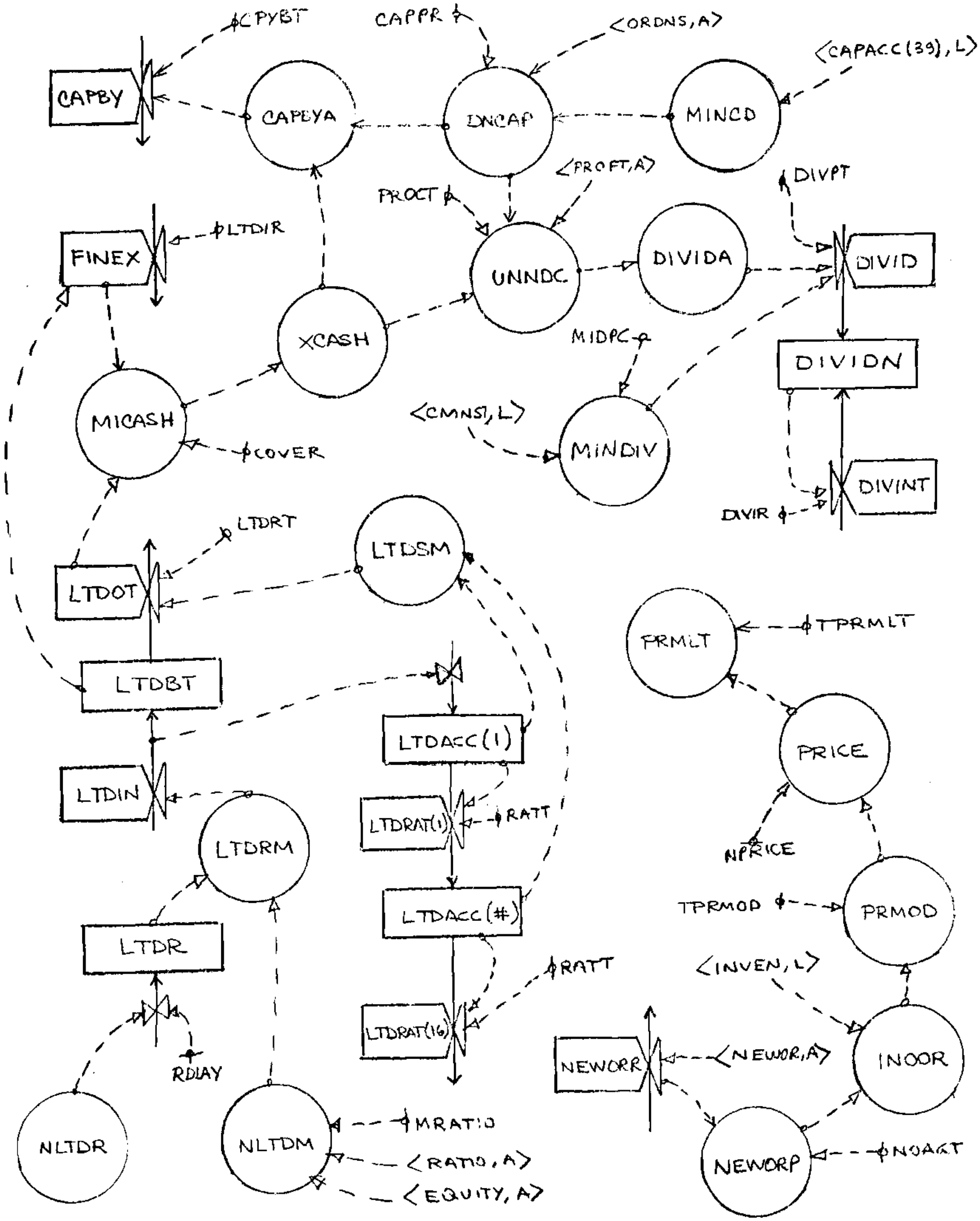


Figure 5.8. Flow Diagram of the Financial Policies Sector

```
A     DNCAP.K=MINCD.K+ORDNS.K/CAPPR
C     CAPPR=.02
```

DNCAP	Total desired new capacity ($)
MINCD	Minimum capacity desired ($)
ORDNS	Orders not shipped last period (units/quarter)
CAPPR	Capacity productivity (units/quarter/$)

A distinction should be made between new capacity desired and new capacity to be acquired. The first is a function of management policies only as it has been shown, but the second is a function of the first and is limited by available funds for capacity. Expansion investments have to be paid when ordered and sometimes lack of cash stops the acquisition of desired new capacity. The next auxiliary equation sets this limitation and will be used in the definition of the capacity buying rate.

```
A     CAPBYA.K=CLIP(DNCAP.K,XCASH.K,XCASH.K,DNCAP.K)
```

CAPBYA	Capacity buying auxiliary ($)
DNCAP	Desired new capacity ($)
XCASH	Extra cash for investment ($)
CLIP	Dynamo decision function

Now that the capacity buying auxiliary has been defined, the next equation representing new capacity buying rate is written:

R CAPBY.KL=CAPBYA.K/CPBYT

C CPBYT=1

CAPBY	Capacity buying rate (\$/quarter)
CAPBYA	Capacity buying auxiliary (\$)
CPBYT	Capacity adjustment time (quarters)

The dividend policy of the company is to give the stockholders at least a minimum constant dividend each quarter equal to a percentage of common stock. The minimum dividend declared and paid each quarter is:

A MINDIV.K=(CMNST.K)(MIDPC)

C MIDPC=.01

MINDIV	Minimum dividend paid (\$/quarter)
CMNST	Common stock (\$)
MIDPC	Minimum dividend percent (%/quarter)

Additional dividends are paid when there is more available cash than that necessary for the company's expansion needs. However the company is not permitted to pay more dividends than the profits earned in the period.

The amount of cash available for dividends will be called unneeded cash in the model and it is represented in the next equation:

A UNNDC.K=MIN((PROFT.K)(PROCT),XCASH.K-DNCAP.K)

UNNDC	Unneeded cash ($)
PROFT	Net profit ($/quarter)
XCASH	Extra cash for investment ($)
DNCAP	Desired new capacity ($)
PROCT	Profit calculation time

An expression for additional dividends paid can be stated now:

A DIVIDA.K=MAX(0,UNNDC.K)

DIVIDA	Dividends auxiliary ($)
UNNDC	Unneeded cash ($)
MAX	Dynamo maximizing function
0	Minimum value of DIVIDA

The total dividends paid each quarter will be either the minimum dividend or the amount indicated by DIVIDA, whichever is bigger:

```
R     DIVID.KL=MAX(DIVIDA.K/DIVPT,MINDIV.K)
C     DIVPT=1
```

DIVID	Total dividends paid ($/quarter)
DIVIDA	Dividends auxiliary ($)
MINDIV	Minimum dividends ($/quarter)
DIVPT	Dividends payment time (quarters)

A new assumption is made to facilitate the analysis of alternative policies in this research. It will be assumed that after dividends are paid, these will earn interest at a rate equal to the rate of interest paid for long term debt.

```
R     DIVINT.KL=(DIVIDN.K)(DIVIR)
C     DIVIR=.0125
```

DIVINT	New interest gain on dividends ($/quarter)
DIVIDN	Dividends accumulated plus interest ($)
DIVIR	Dividend interest rate (%/quarter)

An accumulation for dividends and interest on dividends is now written.

```
L     DIVIDN.K=DIVIDN.J+(DT)(DIVID.JK+DIVINT.JK)
N     DIVIND=0
```

DIVIDN   Dividends accumulated plus interest ($)

DIVID   Total dividends paid ($/quarter)

DIVINT   New interest gain on dividends ($/quarter)

The external financial policy is mainly concerned with obtaining long term funds that are to be used in capacity expansion financing. This research has limited its focus to one kind of external financing source, which is the most commonly used for company expansion purposes. Long term loans is the external financing source that can be used.

The policy of the company is not to use external financing at all, however, the procedure followed to acquire external funds will be explained. This procedure is based on some characteristics found in the Mexican financial market. Since the company will not request any long term debt the variable representing this request is equal to zero:

A   NLTDR.K=0

NLTDR   New long term debt requested ($)

All requisitions are reviewed by the Financial Institutions, and this takes some time. Financial Institutions reviewers check the financial position of the company by the use of the debt to equity ratio. In this model it is assumed that this is the only condition which is important for the issuance of new long term debt. However, a minimum cash balance, which will be explained later in this section, is required.

The test that is involved will be explained here. This test simply states that the loan will be limited by the company's debt-equity ratio and the maximum ratio permitted by the Financial Institution. This condition has been built in the next equation:

```
A     NLTDM.K=MAX(O,(MRATIO-RATIO.K)(EQUITY.K))
C     MRATIO=.25
```

NLTDM	New long term debt maximum ($)
MRATIO	Maximum permitted debt-equity ratio
RATIO	Company's long term debt to equity ratio
EQUITY	Stockholders equity ($)
MAX	Dynamo maximizing function

After one loan is requested, it is reviewed by the Financial Institution which looks at the company's position with respect to the condition explained before. A level equation has been created to represent this temporary delay:

```
L     LTDR.K=LTDR.J+(DT)(1/RDLAY)(NLTDR.J-LTDR.J)
N     LTDR=CLTDR
```

C CLTDR=0

C RDLAY=1

LTDR	Long term debt requested ($)
NLTDR	New long term debt requested ($)
CLTDR	Initial value of long term debt requested ($)
RDLAY	Long term debt request delay (quarters)

An auxiliary equation, in which the minimum of: new long term debt maximum and long term debt requested is obtained, is necessary to simplify the statement of long term debt inflow. This auxiliary equation is:

A LTDRM.K=MIN(LTDR.K,NLTDM.K)

LTDRM	Long term debt requested modified ($)
LTDR	Long term debt requested ($)
NLTDM	New long term debt maximum ($)
MIN	Dynamo minimizing function

The next equation gives the long term debt inflow

R LTDIN.KL=LTDRM.K/LTDDT

C LTDDT=1

LTDIN	Long term debt inflow (\$/quarter)
LTDRM	Long term debt requested modified (\$)
LTDDT	Long term debt delivery time (quarters)

The reader may recall those three array equations in the accounting sector section that were used to later define the capacity depreciation charge. This case of long term debt is similar. This time the interest is on an expression for the outflow of long term debt.

The next equation represents total debt with one quarter of existence.

```
L    LTDACC.K(1)=LTDACC.J(1)+(DT)(LTDIN.JK-LTDRAT.JK(1))
N    LTDACC(1)=CLTDA1
C    CLTDA1=0
```

LTDACC(1)	Long term debt with one quarter of existence (\$)
LTDIN	Long term debt inflow (\$/quarter)
LTDRAT(1)	Long term debt starting second quarter of existence (\$/quarter)
CLTDA1	Initial value of LTDACC(1)

The long term debt equation for LTDPR2 quarters of existence is:

```
L     LTDACC.K(LTDPR2)=LTDACC.J(LTDPR2)+(DT)(LTDRAT.JK(LTDPR2-1)
      -LTDRAT.JK(LTDPR2))
N     LTDACC(LTDPR2)=CLTDAT
C     CLTDAT=0
```

LTDACC(LTDPR2)	Long term debt with LTDPR2 quarters of existence ($)
LTDRAT(LTDPR2-1)	Long term debt moving from LTDPR2-1 quarters to LTDPR2 quarters of existence ($)
LTDRAT(LTDPR2)	Long term debt moving from LTDPR2 to LTDPR2+1 quarters of existence ($)
LTDPR2	Index variable ranging from 2 to 40
CLTDAT	Initial value for all LTDACC(LTDPR2)

Finally the corresponding rate equation is:

```
R     LTDRAT.KL(LTDPER)=LTDACC.K(LTDPER)/LTDAT
C     LTDAT=1
```

LTDRAT(LTDPER)	Long term debt moving from LTDPER to LTDPER+1 quarters of existence ($/quarter)
LTDACC(LTDPER)	Long term debt with LTDPER quarters of existence ($)
LTDAT	Long term debt age time (quarters)

All the contents of the array long term debt equations are added to obtain the total of long term debt contracts outstanding.

A LTDSM.K=SUMV(LTDACC.K,1,16)

LTDSM	Long term debt contracts sum ($)
LTDACC	Long term debt individual contract accounts ($)
1,16	Range of LTDPER
SUMV	Dynamic adding function

In this case LTDPER is an index variable with values from 1 to 16 and LTDPR2 with values from 2 to 16.

The long term debt outflow is simply the sum of long term debt contracts divided by the long term repayment time expressed in quarters.

R LTDOT.KL=LTDSM.K/LTDRT

C LTDRT=16

LTDOT	Long term debt outflow ($/quarter)
LTDSM	Long term debt sum ($)
LTDRT	Long term debt repayment time (quarters)

Financial expenditures are equal to the interests paid for the long term debt held. This is what the next equation represents

R FINEX.KL=(LTDBT.K)(LTDIR)

C LTDIR=.015

FINEX	Financial expenditures ($/quarter)
LTDBT	Long term debt ($)
LTDIR	Long term debt interest rate (%/quarter)

Since the financial institutions require that at least a minimum amount of cash be held for the payment of interest and repayment of debt, the company would need to establish the policy of keeping this minimum cash from other intended uses. The equation for minimum cash balance is:

A MICASH.K=(COVER)(FINEX.JK+LTDOT.JK)

C COVER=1

MICASH	Minimum cash balance ($)
COVER	Coverage minimum (quarters)
FINEX	Financial expenditures ($/quarter)
LTDOT	Long term debt outflow ($/quarter)

Extra cash which is used for the buying of new capacity and the payment of dividends has not been defined before. Its definition is written in the following equation.

A XCASH.K=MAX(0,ACASH.K-MICASH.K)

XCASH	Extra cash for investment ($)
ACASH	Total available cash ($)
MICASH	Minimum cash balance ($)
MAX	Dynamo maximizing function
0	Minimum value of XCASH

The pricing policy of this company is applied whenever overcapacity is reached and the inventory of finished goods surpasses the orders of products by some percentage. The development of the pricing policy is thus based on the behavior of inventory. It is considered that keeping inventories for this product is very costly in this hypothetical company. Remember that in the cash flow sector it was stated that each unit in inventory cost 25 cents each quarter for holding.

The ratio that management utilizes as information to start action against raising inventory is called the inventory-past new orders ratio and it is defined by:

A INORR.K=INVEN.K/NEWORP.K

INORR	Inventory to orders ratio
INVEN	Inventory in units (units)
NEWORP	New orders in the past period (units)

Two equations are necessary to define the amount of new orders in the past period. The first one is called the new orders rate:

R NEWORR.KL=NEWOR.K

NEWORR	New orders rate (units/quarter)
NEWOR	New orders (units/quarter)

The second is the direct definition of past new orders

A NEWORP.K=(NEWORR.JK)(NOAGT)

C NOAGT=1

NEWORP	New orders in the past period (units)
NEWORR	New orders rate (units/quarters)
NOAGT	New orders age time (quarters)

The price of the product is modified with the intention of attracting more orders. The following equation along with the table of constants set the policy of price modification as a function of the inventory-past new orders ratio

```
A     PRMOD.K=TABHL(TPRMOD,INORR.K,0,1,.1)
T     TPROMD=1/1/1/1/.98/.96/.94/.92/.90/.88/.86
```

PRMOD	Price modifier
TPRMOD	Table values for price modifier
INORR	Inventory to orders ratio
0,1	Range of INORR values
.1	Interval size for INORR values
TABHL	Dynamo table function

The relationship of the price modifier and the inventory to past new orders ratio is shown in Figure 5.9.

Price will be changed from its normal value whenever PRMOD is different from one. The equation for the pricing policy is:

```
A     PRICE.K=(NPRICE)(PRMOD.K)
C     NPRICE=4
```

PRICE	Products price ($)
NPRICE	Normal product's price ($)
PRMOD	Price modifier

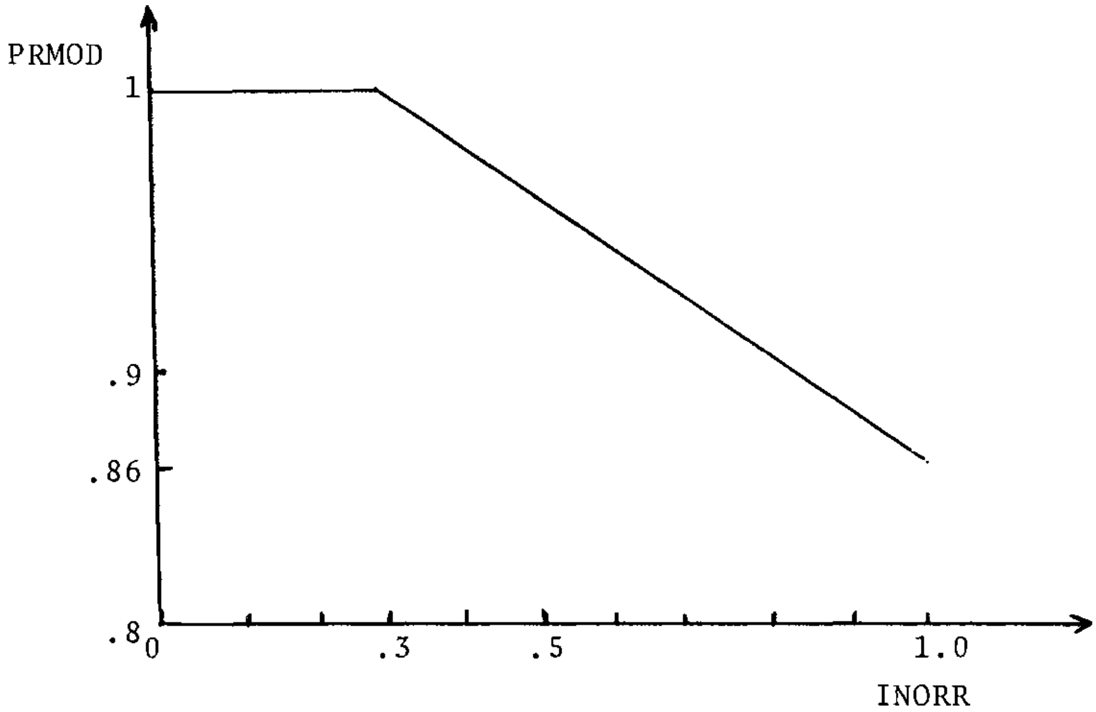


Figure 5.9. Relationship Between PRMOD and INORR

The company expects that a lower price will cause an increase in the number of orders. The next two equations show how the number of orders is modified when a change in the product's price occurs. The first equation with its accompanying table constant values define a multiplier on the number of orders. This was chosen to be called price multiplier.

```
A     PRMLT.K=TABHL(TPRMLT,PRICE.K,3.4,4,.1)
T     TPRMLT=1.6/1.5/1.4/1.3/1.2/1.1/1
```

PRMLT	Price multiplier on orders (dimensionless)
TPRMLT	Table for price multiplier values
3.4,4	Range of values for price
.1	Interval value for price
TABHL	Dynamo table function

The relationship between the price multiplier and the price is shown in Figure 5.10.

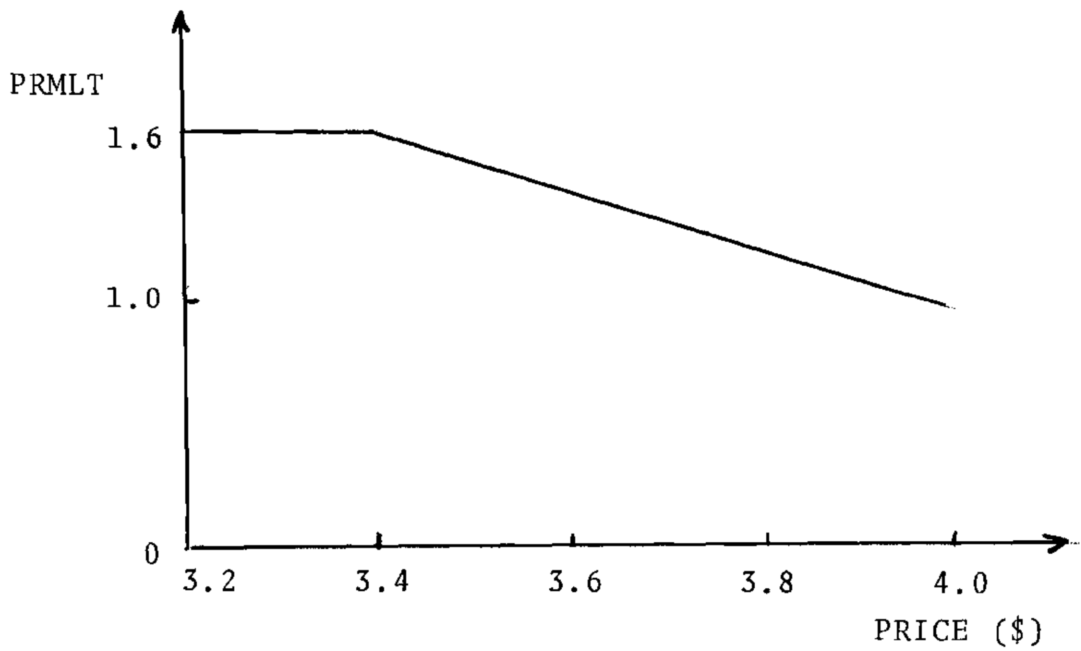


Figure 5.10. Relationship Between PRMLT and PRICE

With this price multiplier and the normal number of new orders, a definition for modified new orders is written:

A NWORM.K=(NEWOR.K)(PRMLT.K)

NWORM	New orders modified (units/quarter)
NEWOR	New orders (units/quarter)
PRMLT	Price multiplier on orders (dimensionless)

All the financial policies have been explained now and every sector of the model has been presented in this chapter. The long and detailed explanation of every equation in the model have been made with the purpose of facilitating understanding of the behavior of the model and the development of improved policies with improved behavior effects.

CHAPTER VI

BEHAVIOR OF THE ORIGINAL MODEL

A. Introduction

This chapter deals with the behavior of the original model which contains a group of policies that reflect the firm's growth behavior characteristics presented in Chapter IV. The original model was run in a digital computer using DYNAMO III. Since the interest of this research is on the financial policies, the behavior of the model under several changes in financial policies will also be explored.

Several plots are presented in this chapter to facilitate explanation. The time scale in the plots and the calculation time used for this simulation is of one quarter. The behavior through time of only the most important variables is shown in these plots. Observe that Table 6.1 gives the variables shown, their names in the model and the symbol used to represent each of them.

The scale used for each of the variables is the same in all the plots. The scale value can be read at the start of the graph. The dynamo compiler uses letters on the scales to represent powers of ten. In the plots presented in this chapter, the following appear:

Table 6.1. Variables Shown in Plots

Variable	Variable Name	Symbol
Effective Capacity	CAPEF	C
Potential Sales	POTSL	*
Effective Salesmen	SLMEF	S
Inventory	INVEN	I
Orders not Shipped	ORDNS	O
Product's Price	PRICE	P
Dividends plus Interest	DIVIDN	A
Dividends plus Interest plus Surplus	DIVSRP	$

T	THOUSAND	1E+3
M	MILLION	1E+6

The letters at the top of the plots represent variables that have the same position value at that time.

B. Original Model Behavior

The behavior of the original model through 25 years of simulation will be presented first. The objective in this section is to gain understanding of the way that the original policies influence the growth behavior of the firm. The reader should refer to Figure 6.2 for the plot of the original model with original policies.

Before discussing the behavior of the model, the original financial policies are rewritten here for quick reference.

(A) A minimum amount of dividends, equal to 1% of the initial value of common stock must be paid to the stockholders each quarter. Additional dividends will be paid only when there is more cash than that necessary for the acquisition of desired capacity and for holding the minimum cash balance. The sum of the two should be limited by the amount of profits earned in the period.

(B) Growth should be sustained through internally generated cash only. No external financing should be used.

(C) The price of the product will normally be $4. The inventory to past new orders ratio will serve to decide any reduction in price, and the exact new prices should be computed from the chart on Figure 6.1.

(D) New production capacity should be ordered ahead of time to replace the old capacity at the time of its retirement. Additional production capacity should be acquired as a function of the number of orders not shipped because of lack of finished goods. Quantitatively this new capacity should be enough to produce the number of orders not shipped in the quarter.

It is necessary to add that the analysis will be partially based on the assumed objective of the hypothetical firm. This objective is contained in the following statement:

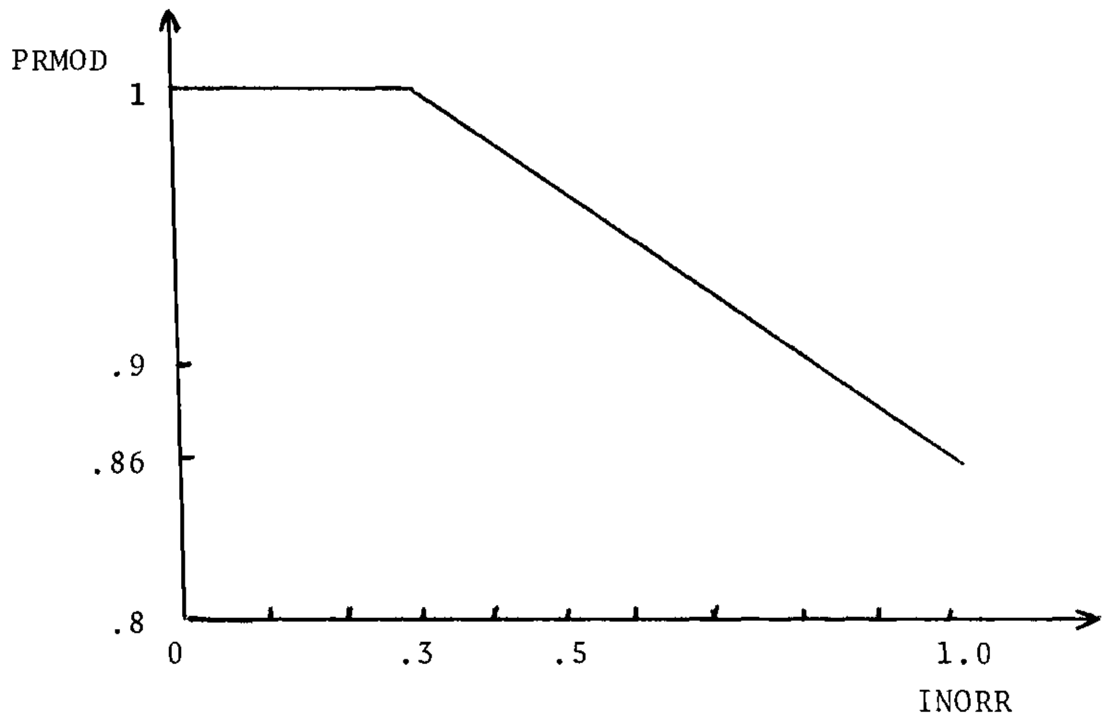


Figure 6.1. Relationship Between PRMOD and INORR

"The company tries to achieve the fastest and most profitable growth and to maximize the wealth of its stockholders."

The plot on Figure 6.2 can be easily divided in two different parts. The first one, including quarters 0 to 53, shows the original model behavior under unlimited market demand. The second shows the behavior under limited market demand.

Making reference to the first part of the plot, observe that production capacity is steadily increased from its original value of 2.5 million to a size of 6.14 million

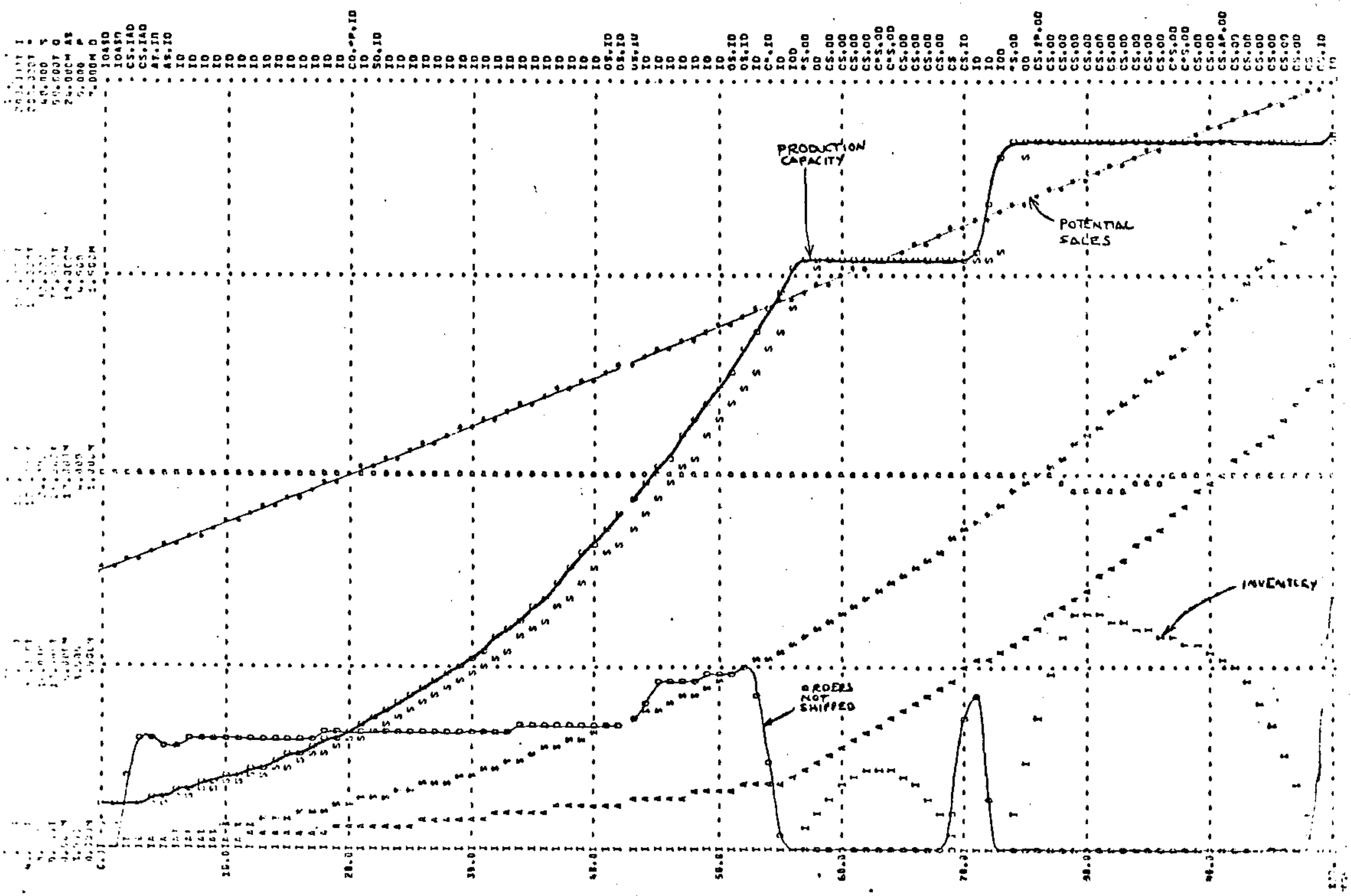


Figure 6.2. Behavior of the Original Model

dollars in the 53rd quarter. An almost constant value of orders not shipped, occuring in this period, means that production was never enough to satisfy the total number of orders generated by the salesmen. It also implies that financial funds were not enough to pay for the total desired investment in production capacity. Inventories remain at a zero level as a consequence of this discrepancy between orders and production.

An important characteristic to be recorded is the time that the company needed to reach a level of capacity that was enough to satisfy potential sales. In this case capacity effective and potential sales are equivalent in the 54th quarter.

The second part of the plot shows a more complicated behavior. The growth of capacity effective does not stop in the 54th quarter. This occurs because additional capacity was bought until the 55th quarter when orders not shipped were still positive. Given that there is a delay of two quarters between the ordering of capacity and the time that it becomes effective, the last increase in effective capacity was recorded in the 57th quarter.

At this time capacity effective stops growing but remains at a constant level because of the policy of minimum investment. Inventory grows because of the overcapacity condition existent, and starts to decrease in quarter 54 when capacity is below the potential sales level again.

Capacity is not increased again, even though it is below the potential sales level, but after the 71st quarter, two quarters after orders not shipped rose from a zero level.

Salesmen are hired when effective capacity starts to increase, but they become effective two quarters afterwards. Inventory does not raise just after capacity surpasses potential sales because orders not shipped is still positive in quarter 73 and are being met by excessive production at that time.

The second overshoot in capacity is bigger than the first and produces a bigger increase in inventory, which at quarter 78 forces the price to decrease to \$3.97 and then to \$3.95 in the next five quarters. This price reduction stops inventory growth even though there is still some overcapacity until quarter 88.

This same process is repeated again after the 100th quarter but the overshooting of effective capacity is bigger and bigger each time because of the delays involved in ordering new capacity when it is below the potential sales level, and in stopping capacity growth when it has surpassed potential sales.

The behavior of dividends paid is different in the two parts. The second part shows a faster growth in accumulated dividends plus interest and it occurs because money is no longer needed to finance a big increase in capacity. The value of dividends paid plus interest is

$15.333 millions at the end of the simulation period.

Another important piece of information that must be recorded for the purpose of future comparisons with other runs is the sum of dividends, interest and surplus which is called DIVSRP in the model. This variable will be referred to as DIVSRP from now on and in this original run has a value of $20.675 millions at the end of 25 years of simulated behavior.

Summarizing, the results show:

(a) First overshoot in capacity appears in quarter 54.

(b) Excessive and insufficient capacity conditions alternatively appear after the 54th quarter and they are more severe each time.

(c) Dividends, interest and surplus total $20.675 million at the end of 25 years of simulation.

C. Behavior of the Original Model with Selected Changes in Policies

In this section several changes in the original model are made, one at a time, to increase the understanding of the behavior of the model.

These changes are only made in the policies of the company, and will demonstrate their influence on the growth behavior of the firm. This has been one of the major concerns of this research. The next chapter will present a model containing improved policies that are derived from the understanding developed in this section.

Five policies are studied in this section, four of which are considered to be of a financial nature. The following presentation summarizes the actual work done in this matter and does not intend to cover every part and detail of it.

The first policy to be studied is not of a financial nature and consequently will be covered briefly. The original policy can be stated in the following terms: "The company desires to have one salesman for every $250,000 of effective capacity."

Management knows that each effective salesman generates 5,500 orders each quarter under unlimited demand. They also know that each $250,000 of effective capacity produces 5,000 units each quarter. Stated in simpler terms, the company wishes to have a 10% excessive sales force. The reason for this original policy is that it is used to detect potential demand and to help in the statement of the capacity investment policy.

The equations related to this policy are:

```
R    SLMHR.KL=SLMND.K/HIRGT
A    SLMND.K=MAX(0,SLMDS.K-TSLMN.K)
A    SLMDS.K=(CAPEF.K)(CAPPR)/PRSLR
A    TSLMN.K=SLMEF.K+SLMTR.K
```

For this policy only changes in parameters will be considered. The policy parameter here is PRSLR, that is the production to salesmen ratio. If no growth in market were taking place, the company would not be interested in having excessive salesmen for the purpose of measuring the potential market. Consequently the value of PRSLR would be the same as the value of MORSL, that is, maximum orders per salesmen, which is 5,500.

The plot on Figure 6.3 shows what happens when no growth is desired. Observe that DIVSRP grows less rapidly than in the original model. The final value of DIVSRP is only of $12.609 million.

Figure 6.4 shows the behavior of the model under a new value of PRSLR of 5,250. Observe that orders not shipped are lower and that an oscillatory pattern starts in the 24th quarter. This produces stops in capacity growth even though the company has not reached potential sales yet. The plot shows that capacity is not equivalent to potential sales but after the 77th quarter. Overshooting of capacity and undercapacity start to occur after that time, in a way similar to that of the original run. DIVSRP amounts to $20.390 million at the end of 25 years with this policy.

Before presenting a conclusion, a summary of two other changes in the value of PRSLR is shown in Table 6.2. along with the two already presented. Time should be interpreted as the time when the company reaches the potential

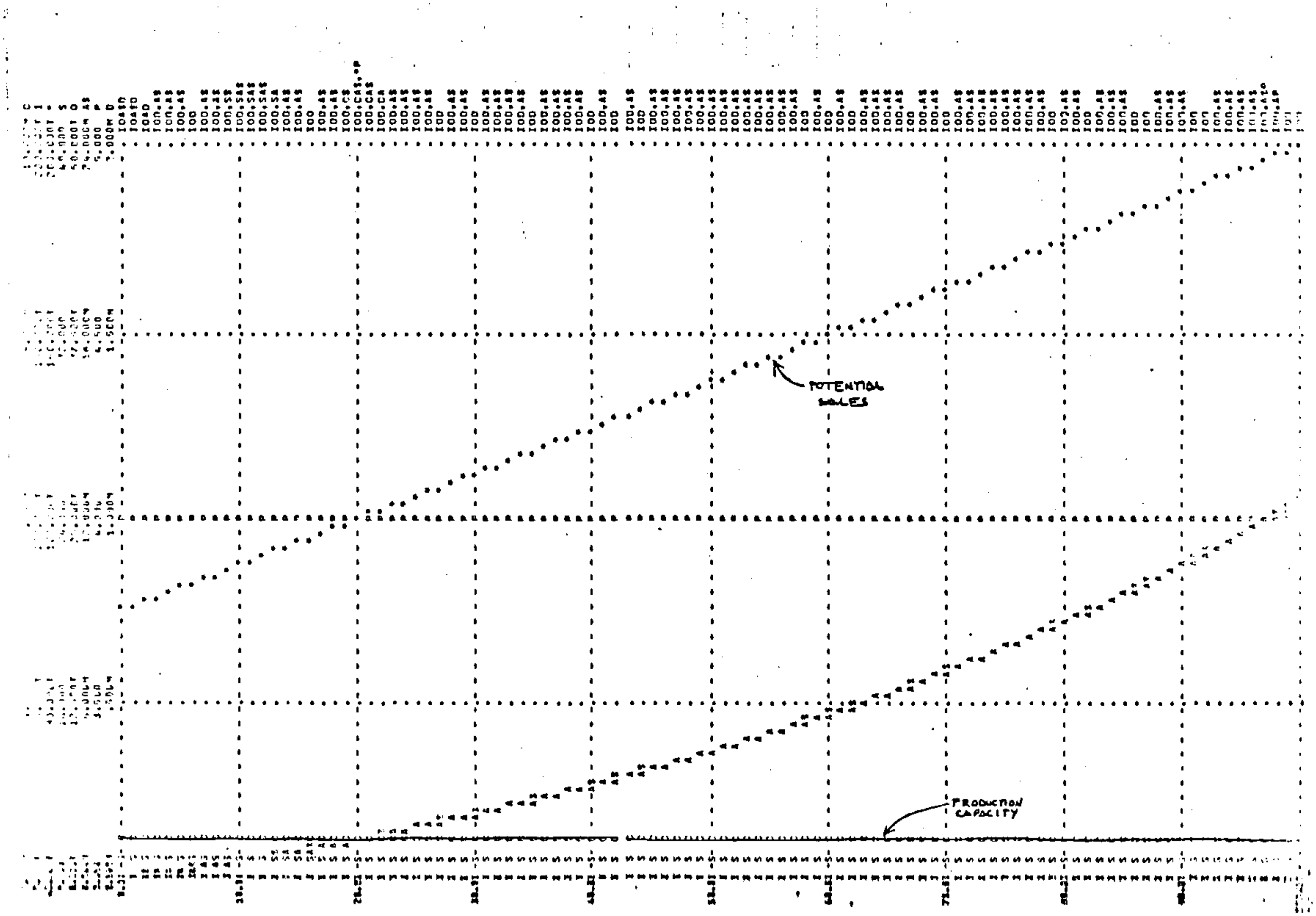


Figure 6.3. Original Model Behavior with PRSLR = 5500

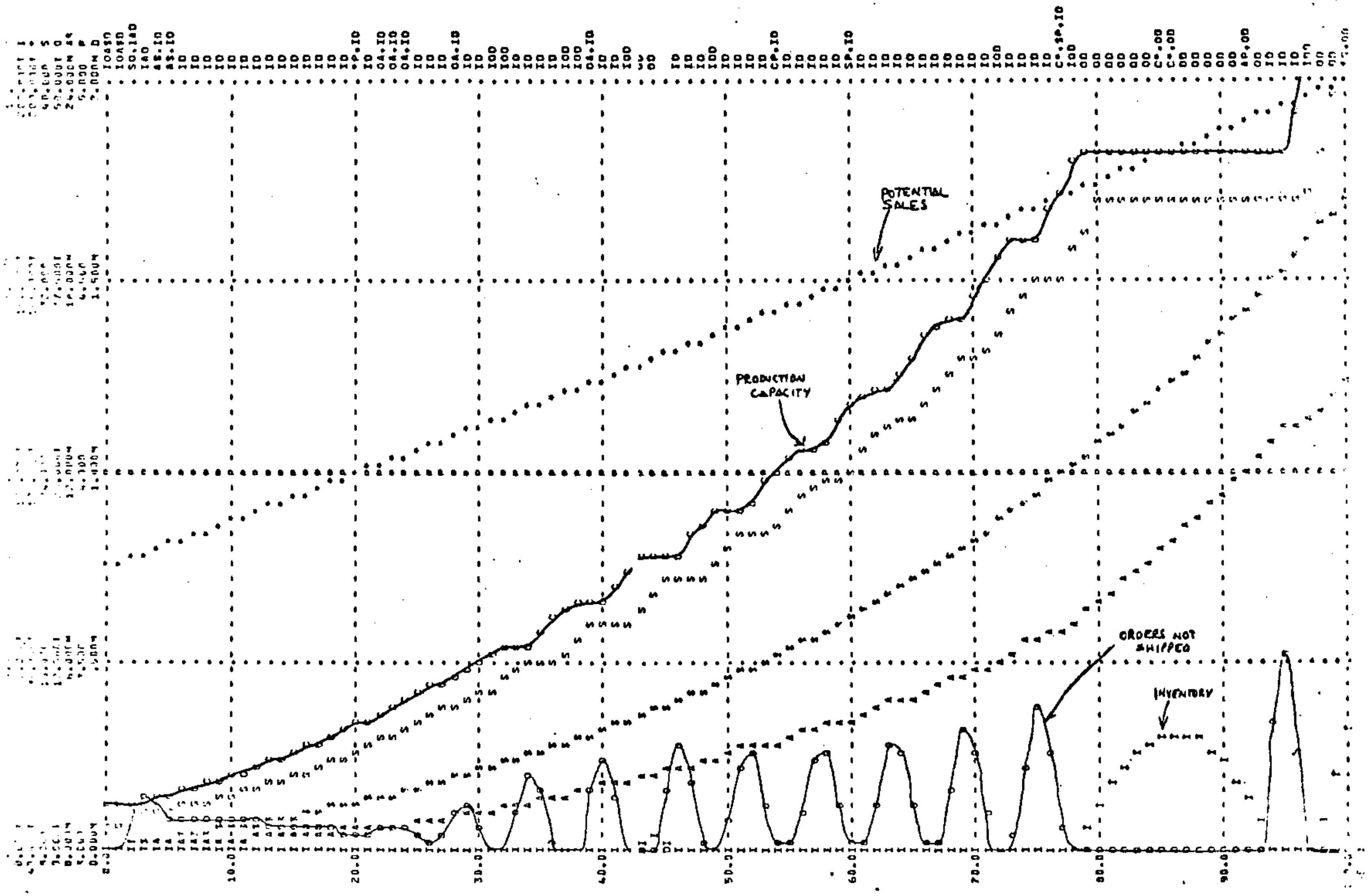


Figure 6.4. Original Model Behavior with PRSLR = 5250

sales level.

Table 6.2. Results with Several Values of PRSLR

PRSLR	DIVSRP	TIME
5000	$20.675M	54
5125	$21.047M	54
5150	$21.269M	54
5250	$20.392M	77
5500	$12.609M	?

A conclusion here is that a small increase in the value of PRSLR produces better results because it decreases total salaries paid without hurting growth and it decreases the size of the capacity overshoots. However, a bigger increase in PRSLR produces even lower total salaries but hurts growth badly.

The second policy studied deals with the amount of dividends that ought to be paid each quarter. The original policy is written at the start of this section. The equations involved are:

```
R     DIVID.KL=MAX(DIVIDA.K/DIVPT,MINDIV.K)
A     MINDIV.K=(MIDPC)(CMNST.K)
```

A DIVIDA.K=MAX(0,UNNDC.K)

A UNNDC.K=MIN((PROFT.K)(PROCT,XCASH.K-DNCAP-K)

Two things are important in this set of equations, the minimum amount of dividends to be paid and the maximum amount of dividends above the minimum, that are to be paid.

The first one is controlled by a policy parameter called minimum dividend percent, MIDPC. It is intuitively known that the more funds available the less will be the discrepancy between desired new capacity and actual new capacity. This is easily demonstrated in Figure 6.5 that represents a run with a policy of no minimum dividends, that is, with MIDPC=0.

Observe that the behavior of the variables is similar to that in the original run but that the time needed to reach potential sales is much shorter than in the original run. In this case its value is only 38 quarters. The amount of DIVSRP at the end of the 25 years is $21.686 million, 4.8% greater than in the original.

A summary of two other runs and the two already presented appears in Table 6.3.

The second important part of this policy is the statement of the amount of dividends that are to be paid when there is unneeded cash. The definition of unneeded cash is what counts in this case.

In the original model, unneeded cash is defined as the

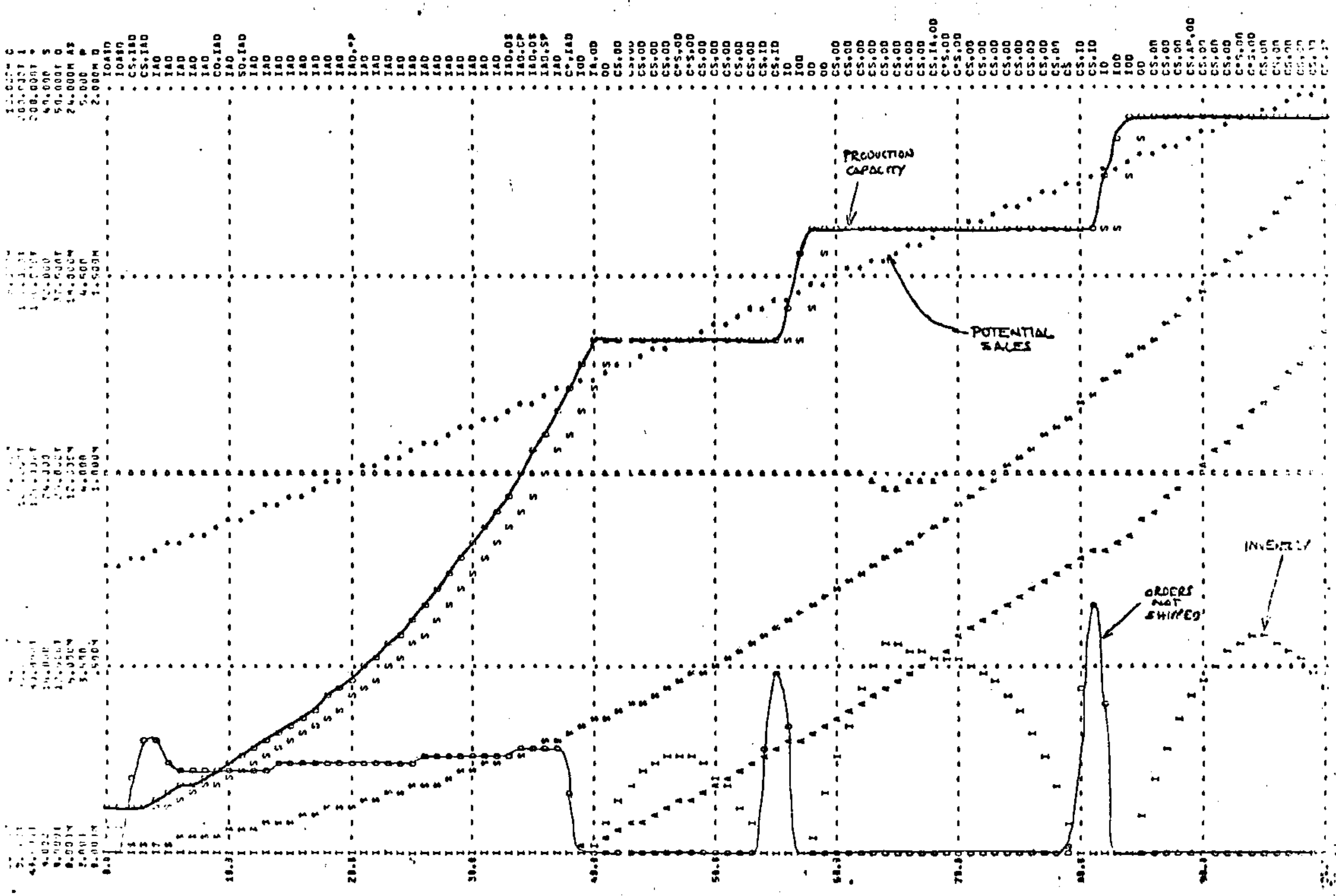


Figure 6.5. Original Model Behavior with MIDIV = 0

Table 6.3. Results with Several Values of MIDPC

MIDPC	DIVSRP	TIME
0	$21.686M	38
.005	$21.364M	44
.01	$20.675M	54
.015	$19.085M	71

difference of extra cash for investment and desired new capacity, but it is limited by the amount of net profits in the quarter. It looks like the policy is all right because money which will not be used in the following quarter is indeed unneeded. A second thought on the subject may raise the question: What if there is a need two or three quarters from the present one, and at that time the extra cash available for investment is not enough to pay for the desired new capacity? This suggests a more conservative definition of unneeded cash in which less money is said to be unneeded. One such policy is illustrated in the following definition of unneeded cash, and the resulting behavior is shown in Figure 6.6.

```
A    UNNDC.K=MIN((PROFT.K)(PROCT),XCASH.K-(XX)(DNCAP.K))
C    XX=1.2
```

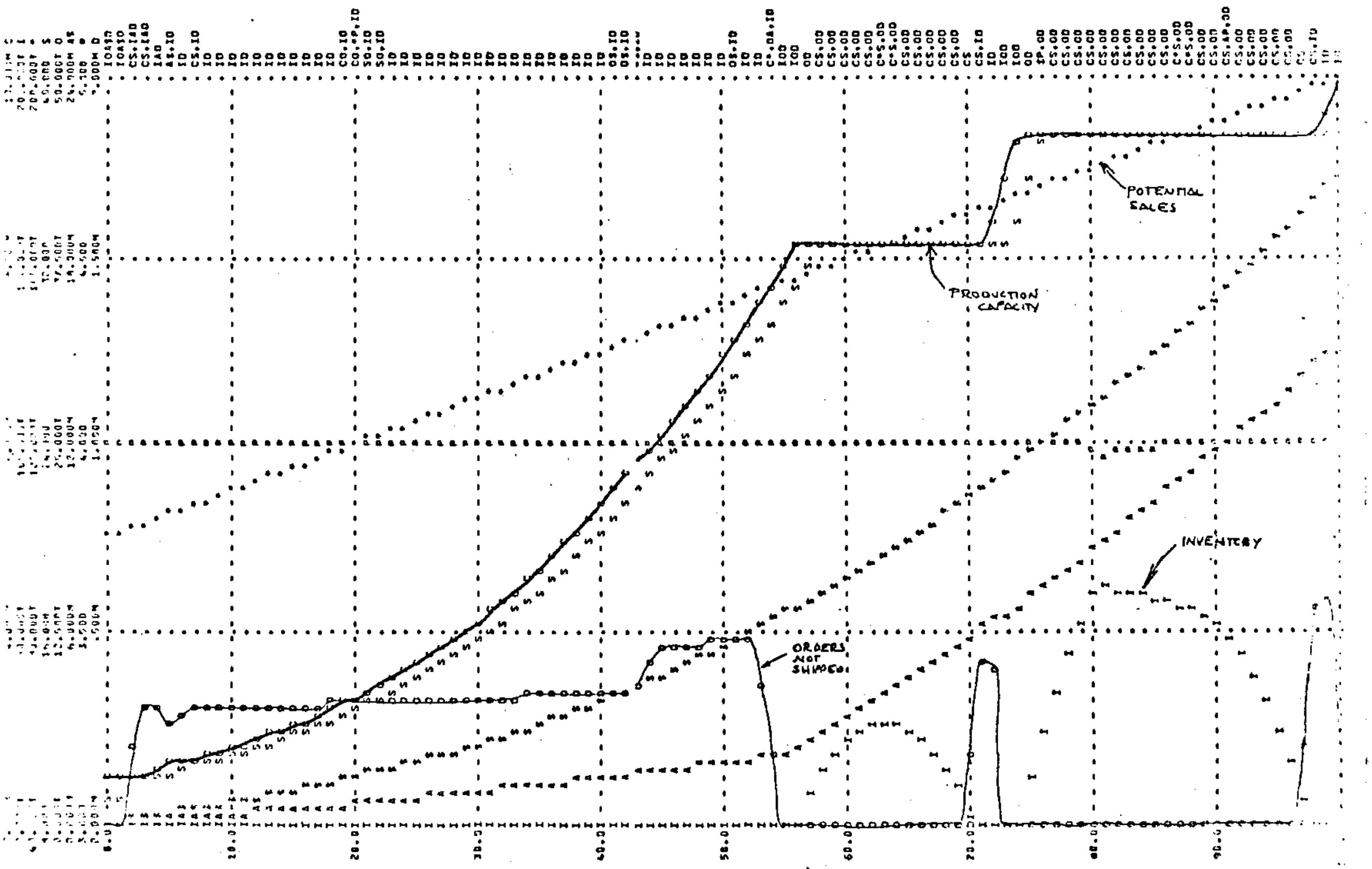


Figure 6.6. Original Model Behavior with New UNNDC

The equations state that only extra cash that is left after substracting 1.2 times the amount of desired new capacity will be available for dividends.

The results obtained with this new dividend policy are almost identical to those in the original model. The amount of DIVSRP just rises slightly to $20.720 in the 100th quarter.

The results that have been obtained with the changes in the original dividend policy show that the most influential part of this policy is the amount of minimum dividends.

The pricing policy is considered next. The equations representing the policy that was written at the start of the section are:

```
A     PRICE.K=(NPRICE)(PRMOD.K)
A     PRMOD.K=TABHL(TPRMOD,INORR.K,0,1,.1)
T     TPRMOD=1/1/1/1/.98/.96/.94/.92/.90/.88/.86
A     INORR.K=INVEN.K/NEWORP.K
```

The relationship between the inventory to past new orders ratio and the price modifier is shown in Figure 6.7.

A couple of things about this policy are important. The first one has to do with a definition of a ratio or other measure with which decisions of price are made. It has been assumed that there is no change in the cost of the production and selling resources utilized and that increases or decreases

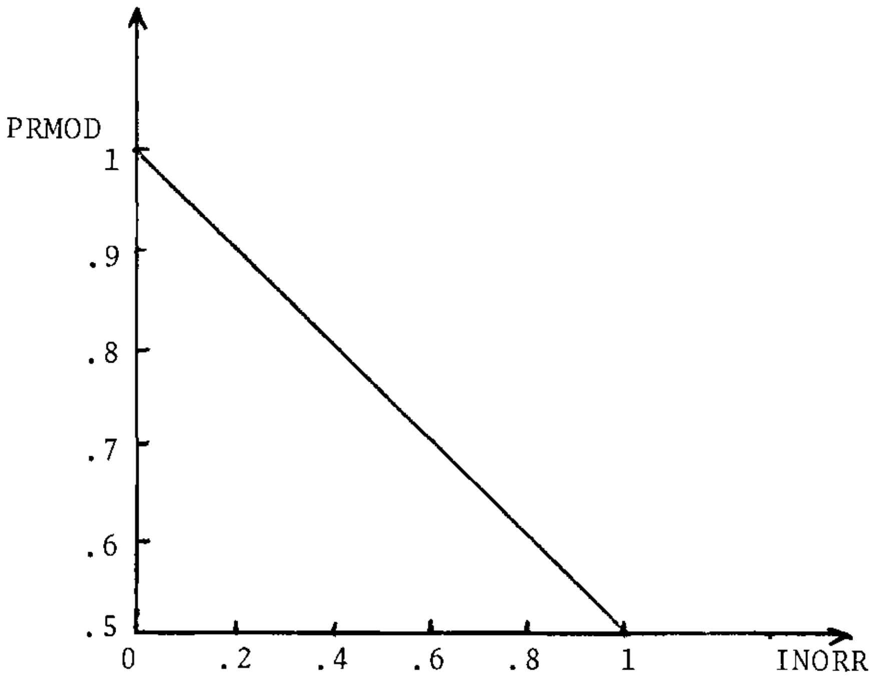


Figure 6.7. Relationship Between PRMOD and INORR

from the normal price are usually not convenient because of the close competition existing in the industry. However, the price can be modified with good results when the company is faced with excessive inventory because the profit lost may be offset by a reduction in inventory carrying costs. It has also been assumed that the company knows exactly the reaction of the market to a change in price, that is, they know what the relationship between price and the price multiplier on orders is.

The original ratio utilized for the pricing policy is the ratio of inventory to past new orders. Present new orders would have been more desirable to use but they can not be identified before the price decision is made.

Some very small changes occur if other variables, like total orders or new orders modified, are used in the denominator of the ratio. This occurs because the present policy does not react to a ratio of less than .3 and when it does it reacts very slightly. A better understanding of this reasoning is obtained when the second important thing in the policy is considered.

The second feature of this policy is the table values for price modifier if a new set of values were introduced, the behavior of price would be different. Several sets of values were used to test this policy. Three of them are reported in Table 6.3 and the run of one of them can be seen in Figure 6.8.

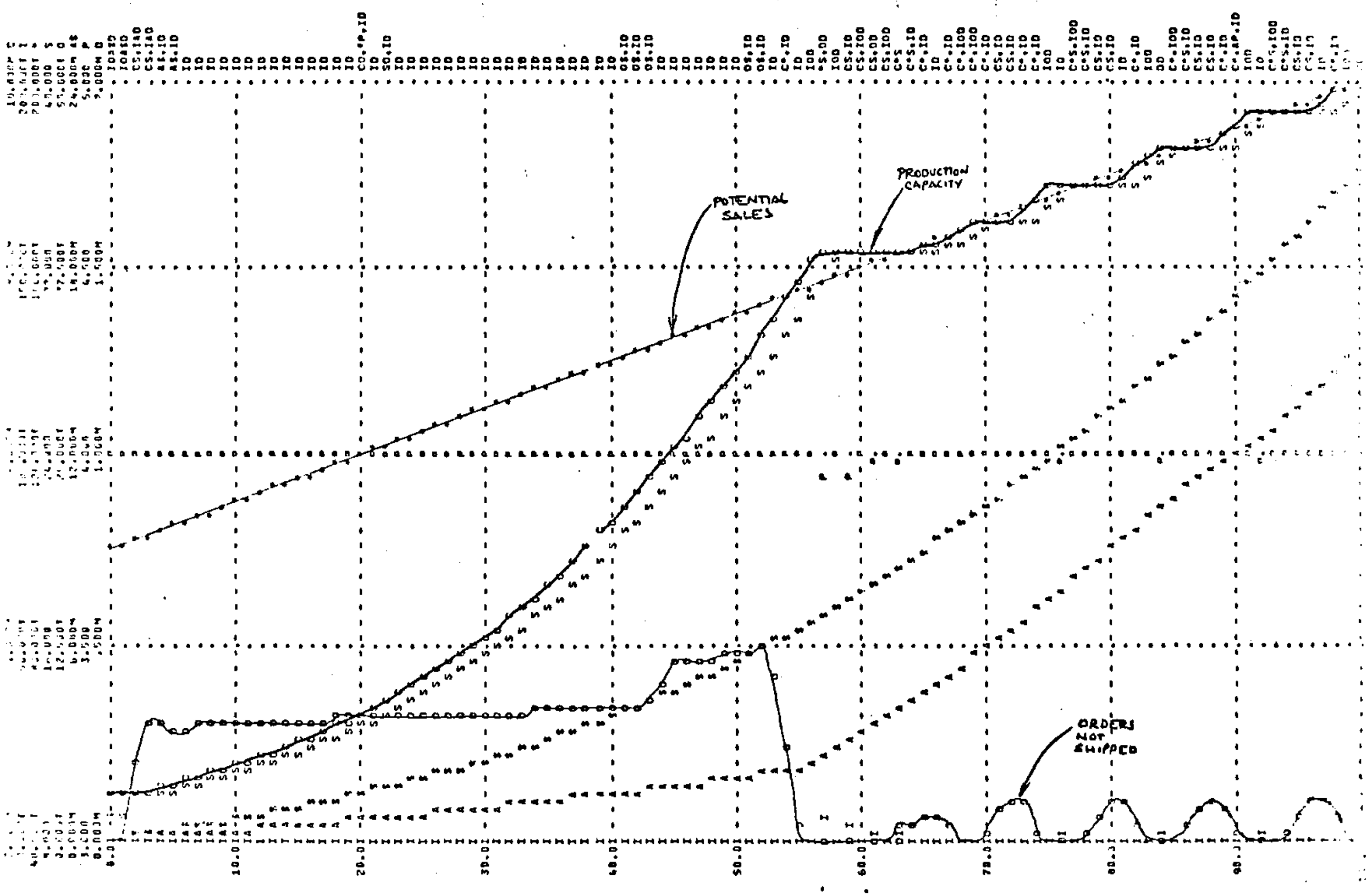


Figure 6.8. Original Model Behavior with TPRMOD = 1/.95/.90/.85/.80/.75/.70/.65/.60/.55/.50

The set of values chosen for the run shown were:

TPRMOD=1/.95/.90/.85/.80/.75/.70/.65/.60/.55/.50

This change implies that the reaction to excessive inventory will be faster and greater. Observe in Figure 6.8 that the behavior of the system is improved in the second part of the graph because of a more effective pricing policy. The big overshoot in capacity is eliminated because there is a faster reaction to under and overcapacity conditions. This faster reaction occurs because inventory and orders not shipped do not take big values and are not positive for long times.

The summary of four different runs including one with the original policy will help in drawing conclusions about changing the timing of the reaction and its size.

Table 6.4. Results with Several Values of TPRMOD

TPRMOD	DIVSRP	TIME
1/1/1/1/.98/.96/.94/...	$20.675M	54
1/.98/.96/.94/.92/...	$21.132M	54
1/.95/.90/.85/.80/...	$21.155M	54
1/.90/.80/.70/.60/...	$18.835M	54

An improvement in DIVSRP can be appreciated when the pricing policy reacts more rapidly to excessive inventory. This is concluded by looking at the results of the first and second policies shown in Table 6.4.

An improvement in DIVSRP can also be obtained by increasing the size of the price reduction, but this should not be taken without care because increased price reductions make the results worse as can be shown with the comparison of the first, third and fourth policies on Table 6.4.

An overall conclusion for the pricing policy is that the ratio used to make decisions about price and the readiness and size of the changes in price definitely influence both the behavior and the profitability of the company.

The attention should now be turned to the capacity investment policy. This is a very important financial policy. A simple statement was written at the start of this section and the equations involved are:

```
R     CAPBY.KL=CAPBYA.K/CPBYT
A     CAPBYA.K=CLIP(DNCAP.K,XCASH.K,XCASH.K,DNCAP.K)
A     DNCAP.K=MINCD.K+ORDNS.K/CAPPR
A     MINCD.K=CAPACC.K(39)
```

Making reference to the plot of the original model in Figure 6.2. it is observed that the policy of buying enough capacity to cover the capacity becoming useless, in other words, buying at least what the equation for minimum capacity desired says, is not efficient in times of over-capacity and in general after the level of potential sales is first reached because it inhibits a leveling off of the inventory and on the contrary increases it.

An exploration with a new policy is made. In this policy no minimum replacement of capacity is mandatory after the company reaches the level of potential sales. Several equations had to be added to the original model to permit the introduction of a change in policy after fast growth ceases:

```
A     INDREC.K=MIN(INDEX.K,PINREC.K)
L     PINREC.K=PINREC.J+(DT)(INDREC.J-PINREC.J)
N     PINREC=1
A     INDEX.K=NEWORP.K/MAXORP.K
A     MAXORP.K=(MAXORR.JK)(MOAGT)
R     MAXORR.KL=MAXOR.K
```

This set of equations is fully explained in the next chapter, the equation that represents the new policy is:

```
A     MINCD.K=CLIP(CAPACC.K(39),0,INDREC.K,1)
```

This equation states that minimum capacity desired will change from a value given by CAPACC.K(39) to zero after the index record variable, INDREC, has a value of less than one.

The results obtained with this new policy are shown in Figure 6.9. Notice that as expected, the behavior of the variables is not altered during the fast growth period. The second part of the plot shows the behavior obtained with the new policy. The interesting thing to observe here is that capacity effective does not level off after an overshooting occurs but that it starts to decrease steadily until one period after the inventory level goes back to zero. This is what was expected to occur with the introduction of the new policy. It may be concluded that no improvement in behavior has taken place with this new policy.

Quantitatively the firm was better off with the original policy because this new policy gives a value of only $20.189 millions.

Another possible change in the original investment policy is with the second term of desired new capacity. A new policy was explored in which the second term in the equation for desired new capacity was multiplied by one half. The equation that had to be changed is shown below already modified.

```
A     DNCAP.K=MINCD.K+(.5)(ORDNS.K)/CAPPR
```

The resulting behavior can be observed in Figure 6.10. A very important conclusion can be drawn by observing the

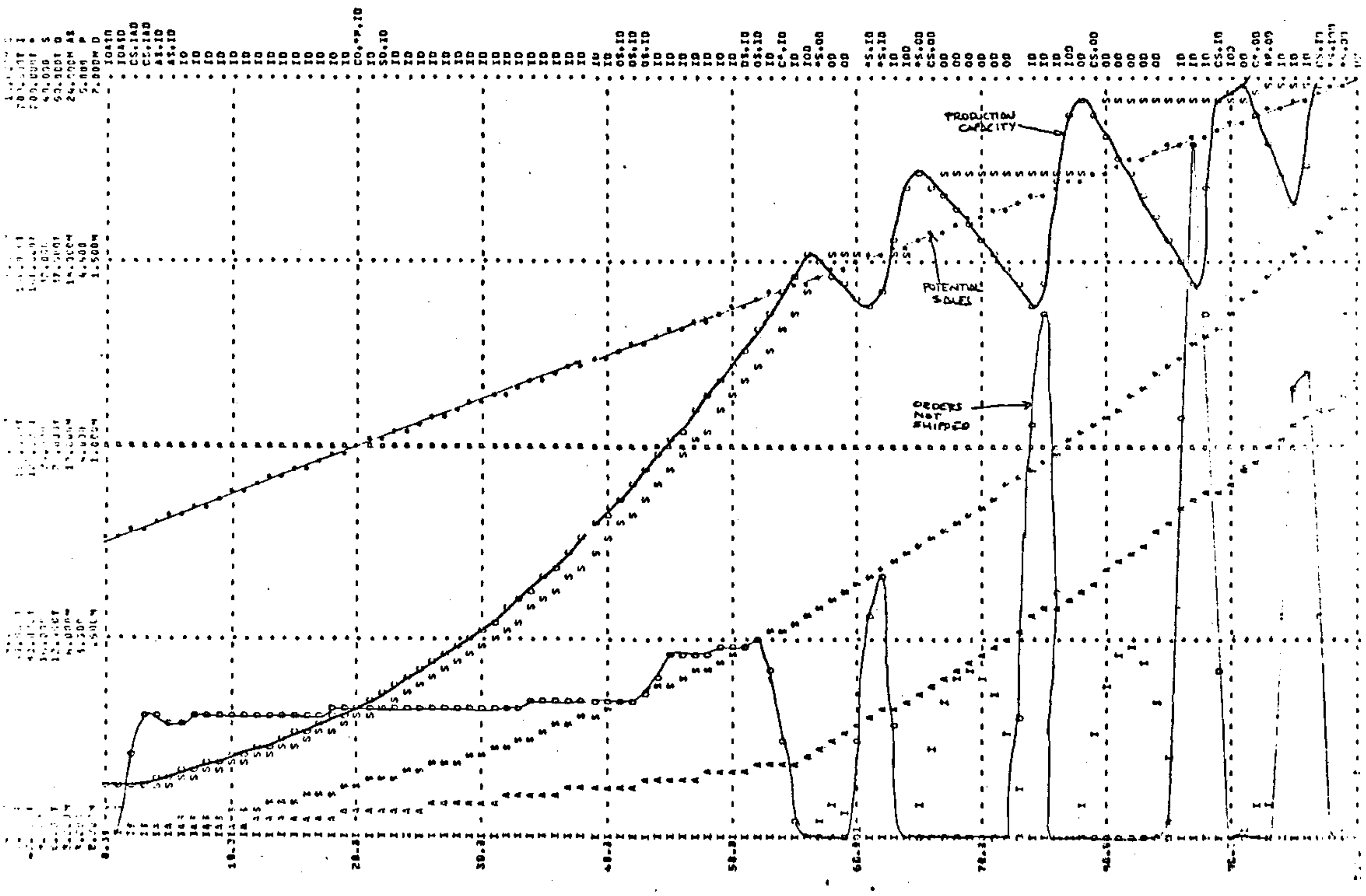


Figure 6.9. Original Model Behavior with New MINCD Formulation

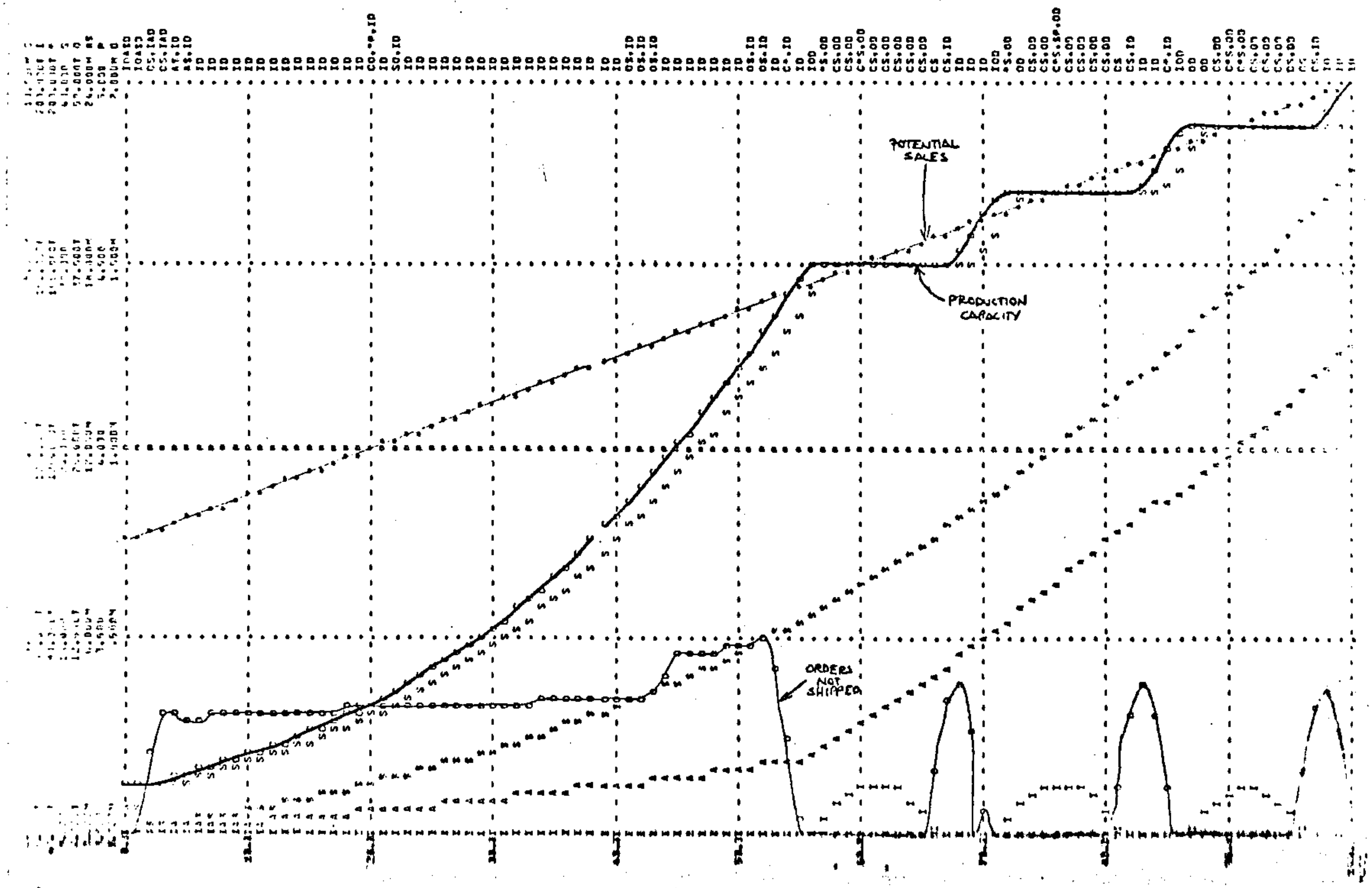


Figure 6.10. Original Model Behavior with New DNCAP Formulation

behavior during the first stage and by looking the new policy equation over. The equation reflects the fact that desired new capacity is at least one half of the second term lower than the desired new capacity value obtained in the original policy. However, the original behavior is not altered during the first stage. In examining the model it is found that this occurs because expansion is limited by available funds, and not by desired new capacity, during this stage.

During the second stage an improvement in the behavior is found. This is concluded after observing the new behavior of effective capacity and of inventory. The overshoot in capacity is less severe. This improvement is also recorded on the final value of DIVSRP, $21.044 millions, which is $369,000 greater than in the original run.

A third change in the original policy is presented now. The question leading to this change is: What if a new term was added to the original desired new capacity equation with a negative value of CAPOI? The intention of this new term is to take into consideration the capacity being installed before making a decision of new desired capacity. The original equation is modified and is written:

```
A     DNCAP.K=MAX(0,MINCD.K+ORDNS.K/CAPPR
```

The behavior resulting from this change in policy is shown in Figure 6.11. Observe that there is a slight modification during the first stage. It takes 57 quarters instead of 54 for the company to reach a level of capacity compatible with the level of potential sales. The second stage shows a quite different behavior of effective capacity and of orders not shipped. Effective capacity is steadily increased from quarter 60 to 99 but it remains below the level of potential sales, causing a permanent positive value of orders not shipped during this interval. In quarter 99 effective capacity increases sharply because of the very high investment made in quarter 58. Remember that new capacity becomes obsolete and unproductive after 40 quarters of use. However this sharp increase soon ends and capacity effective goes back to a level below that of the potential sales. This is not shown in the plot, but it was found in another enlarged plot.

The quantitative results show that this policy is just slightly better than the original one. The new value of DIVSRP is $20.713 millions.

A summary of the results obtained with the three new policies just presented is shown in Table 6.5.

The last policy to be discussed in this chapter is the external financing policy. In the original model it was chosen not to use external financing and this is what the next equation states:

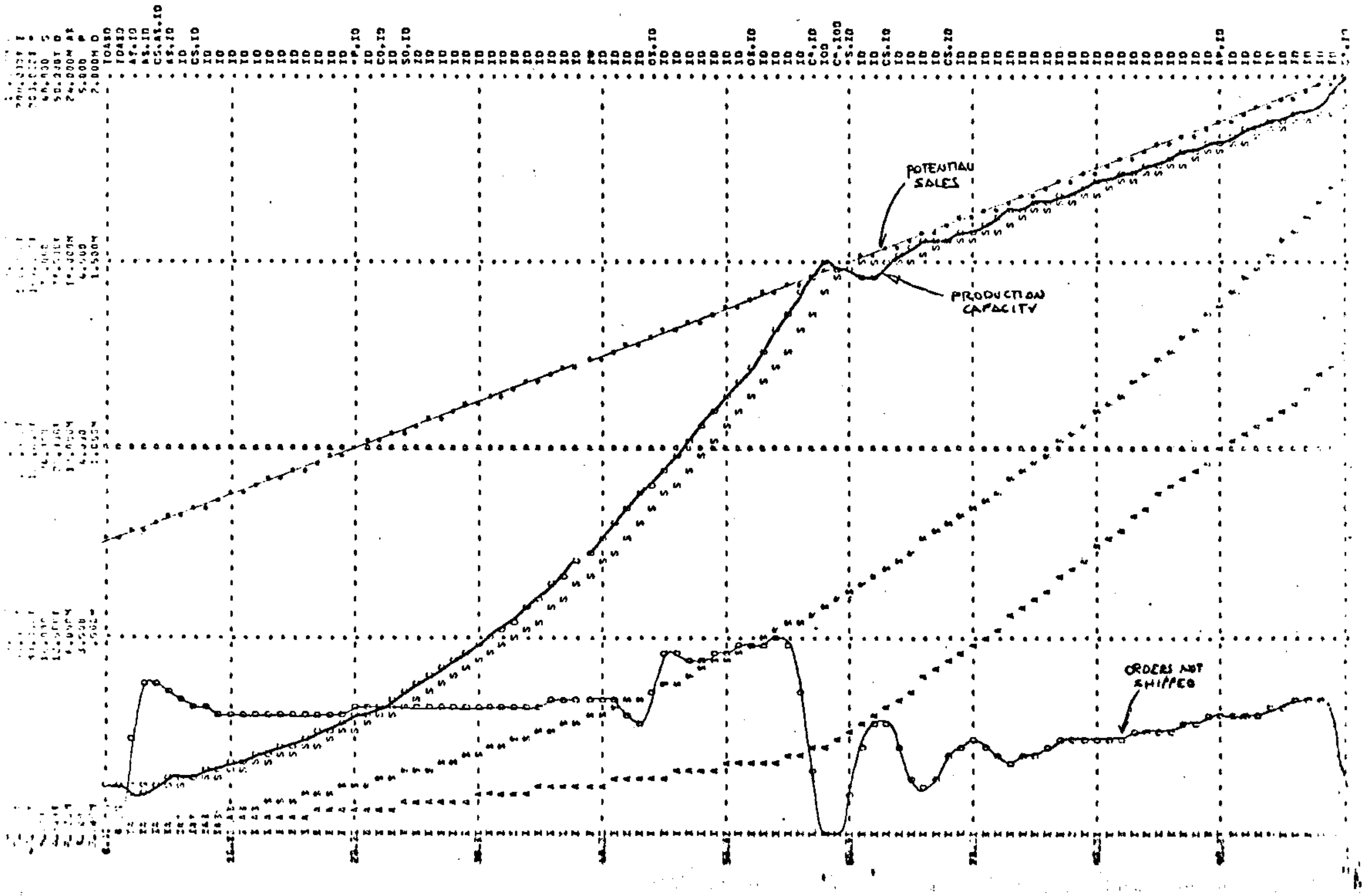


Figure 6.11. Original Model Behavior with New DNCAP Formulation

Table 6.5. Results with Several Capacity Policies

Policy	DIVSRP	TIME
MINCD.K=CLIP( )	$20.189M	54
DNCAP.K=...(.5)(ORDNS)...	$21.044M	54
DNCAP.K=...-CAPOI.K	$20,713M	57

A NLTDR.K=0

Many small businesses do not use external financing for several reasons. One of the reasons more commonly encountered in underdeveloped nations is that management is not sure of how and where to get external funds. It is this limited knowledge of the financial market that keeps them from using this source of funds, rather than the felt risk of being unable to meet repayment schedules of principal and interest. Generally there is an advantage in doing business with borrowed money. The advantage is always present in firms with enough growth potential to permit increasing profits. This is the case of the hypothetical company being modeled, at least during the period of fast growth.

Several new policies were explored but only one was chosen as an example. The result of the study of the other policies is reflected in the external financing policy presented in the next chapter. Nevertheless, the summarized results of other two policies are presented in Table 6.6.

The policy chosen can be stated in simple terms: "The company will request enough long term debt each quarter to maintain an average long term debt to equity ratio of 20%. This policy will be only applied during the fast growth state."

The equations necessary to include that policy in the original model are:

```
A     INDREC.K=MIN(INDEX.K,PINREC.K)
L     PINREC.K=PINREC.J+(DT)(INDREC.J-PINREC.J)
N     PINREC=1
A     INDEX.K=NEWORP.K/MAXORP.K
A     MAXORP.K=(MAXORR.JK)(MOAGT)
R     MAXORR.KL=MAXOR.K
```

Which is the same set of equations presented in the last policy reviewed and the following two equations define the policy:

```
A     NLTDR.K=(EQUITY.K)(PC)-LTDBT.K
C     PC=.20
```

The two equations for the policy state that the new long term that should be requested each quarter should be equal to the difference of equity times a percentage that in this case is 20 and the present long term debt. This policy is applied only when the index record for fast growth is bigger or equal to one, that is, only during the fast growth stage.

The resulting behavior obtained with this policy is shown in Figure 6.12. This is a very useful run because several important conclusions can be reached from its analysis. The initial long term debt condition and the delay introduced in this policy cause a big jump in the value of long term debt at the start of the simulation. Because of this jump, the long term debt to equity ratio is exceeded and a slow return to the desired value of 20% is shown from quarters 3 to 8. After this, a small oscillatory pattern of long term debt is observed which is caused by the delay involved in the external financing policy.

Effective capacity increases sharply in the 4th and 5th quarters given that there is enough money to buy the desired amount on new capacity. Observe that this sharp increase in capacity causes inventory to raise because there are not enough effective salesmen at that time, they are being trained. This jump in capacity also causes a negative jump in capacity in quarters 43 and 44. The reason is that at that time a big replacement investment had to be made but there are not enough funds to pay for it and the replacement is only partial. This is a rather useful observation that will help in the design of the improved policies in the next

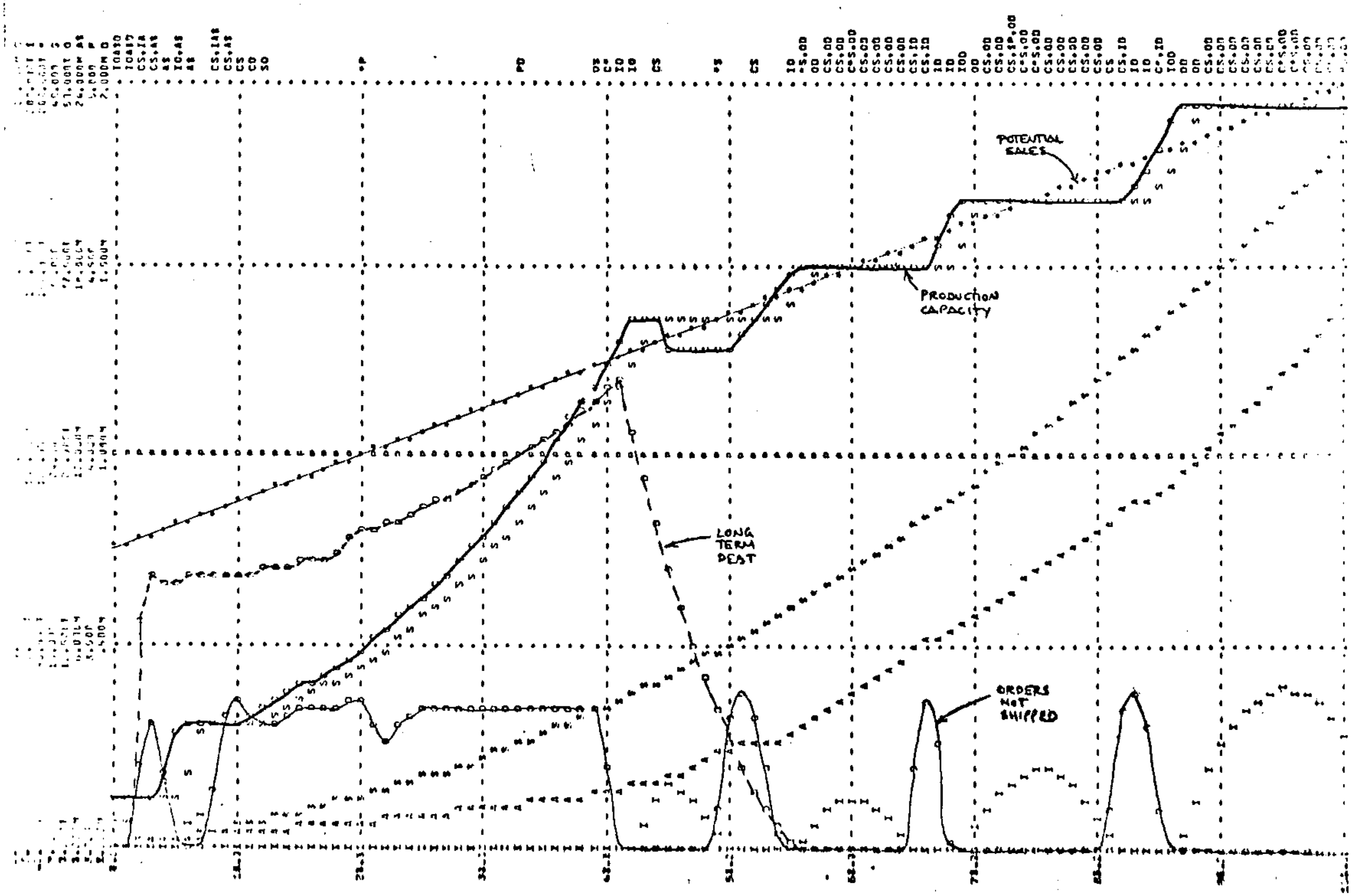


Figure 6.12. Original Model Behavior with New NLTDR Formulation

chapter.

The level of potential sales is reached in quarter 41. The behavior of the variables following the end of the first stage is similar to that of the original policy with the only exception of the small decrease in capacity in quarters 43 and 44.

This observation led to the conclusion that long term debt accelerates growth but that it should be used with care in order to prevent undesirable behavior.

Table 6.6 shows a summary of four different policies which can be generated by changing the value of PC in the list of equations presented before.

Table 6.6. Results with Several Financing Policies

PC	DIVSRP	TIME
0	$20.675M	54
.10	$21.441M	48
.20	$21.889M	41
.30	$21.999M	40

The trend derived from observation of the last table suggests that a greater use of debt can lead to a greater rate of growth. However, the model limits the long term debt equity ratio to 25% and no big difference is obtained requesting debt with PC=.20 and with PC=.30 as can be seen in the values reported in the table.

CHAPTER VII

STRUCTURE AND BEHAVIOR OF AN IMPROVED MODEL

A. Introduction

The previous chapter presented the behavior of the model under original policies. The behavior of the main variables was analyzed not only directly from the results obtained through the simulation of the original model, but also from results obtained after several single modifications of the original policies were made. The presentation in Chapter V covered only part of the work done in the area of modification of policies for improvement in behavior. There was no mention of several changes in policies made at one time, although this was part of the work done in the research.

This chapter will present an improved model, consisting of the original model plus modification of financial policies, that resulted from the analysis of single and multiple changes in financial policies. The intention of this research has not been optimization of a model. It has been understanding of the way that financial policies influence growth behavior.

B. Formulation of the New Policies

An understanding developed from the analysis of the original model is that the company needs changes in policies after the condition of unlimited demand or fast growth has ended. A partial exploration of this idea was presented in the last chapter, when the policy of capacity investment and of external financing was studied.

The improved policies presented in this chapter require that the model be extended to include a set of equations that permit a change in policies after the first stage of growth has ended. The following five equations were designed to serve that purpose in the model.

An index that can be used to realize when the potential sales has been reached is the ratio of new orders in the past period and maximum orders in the past period. This ratio is always equal to one before the level of potential sales is reached. After that the ratio may have values of one or less than one. However it is true that it will be less than one just after the number of orders that salesmen would normally generate is bigger than the level of potential sales. The equation for this index is:

A INDEX.K=NEWORP.K/MAXORP.K

INDEX	Index for policy change
NEWORP	New orders in the previous period (units)
MAXORP	Maximum orders in the previous period (units)

Past new orders was already defined in Chapter V. Past maximum orders (units) is defined by the following equations. The first is the rate of present maximum orders to past maximum orders:

R MAXORR.KL=MAXOR.K

MAXORR	Maximum orders rate (units/quarter)
MAXOR	Maximum orders (units)

The second is the direct definition of maximum orders in the previous period:

A MAXORP.K=(MAXORR.JK)(MOAGT)

C MOAGT=1

MAXORP	Maximum orders in the previous period (units)
MAXOR	Maximum orders rate (units/quarter)
MOAGT	Maximum orders age time (quarters)

It was mentioned before that the index may be less or equal to one in the second stage. To prevent a further change in policies after the first is made, a record of the index is kept and it is what will be used in the formulation of the new policies. The index record is given by:

```
A     INDREC.K=MIN(INDEX.K,PINREC.K)
```

INDREC	Index record
INDEX	Index for change in policy
PINREC	Previous index record
MIN	Dynamo minimizing function

That is, the index record is equal to the present index only if it is smaller than the previous index record. A level equation is needed for the previous index record:

```
L     PINREC.K=PINREC.J+(DT)(INDREC.J-PINREC.J)
N     PINREC=1
```

PINREC	Previous index record
INDREC	Index record

Before explaining each improved policy, they are stated below.

(1) The pricing policy is summarized in Figure 7.1.

(2) No dividends are paid during the first stage of growth. In the second stage, the smaller of profits and unneeded cash is declared a dividend.

(3) New capacity investments are limited to 15% of

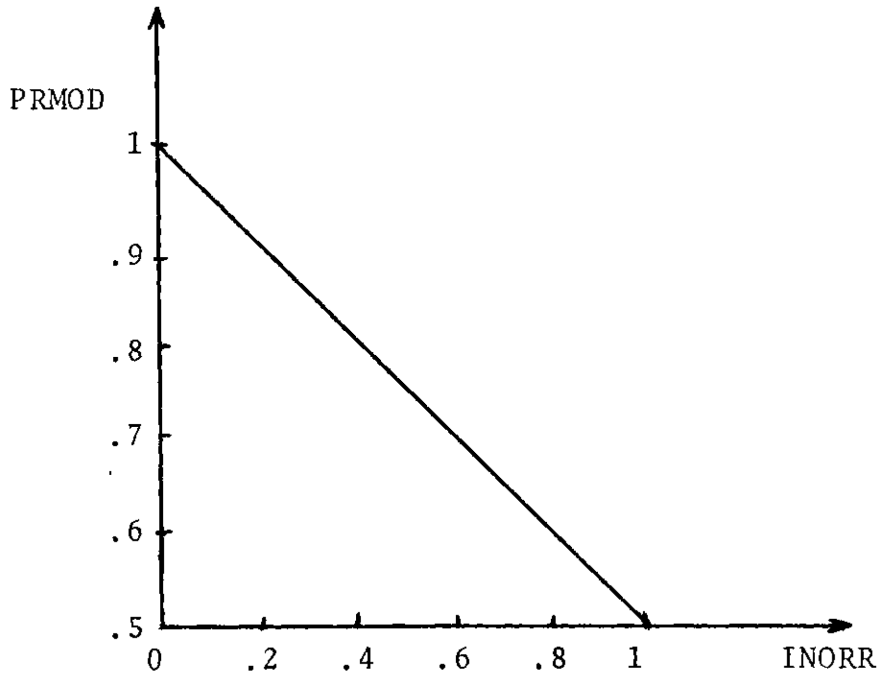


Figure 7.1. Relationship Between PRMOD and INORR for Improved Policy

present capacity. A minimum investment, to replace the capacity being retired, should be made each quarter. During the fast growth stage, all desired capacity indicated by orders not shipped is ordered, but only 80% of it is ordered during the second stage.

(4) Long term debt should be used during the first stage only. However, the total should not be greater than 25% of the value of equity.

The new improved policy of pricing is designed to react faster to changes in inventory. This has been found to be desirable. The new policy is introduced by changing the values of the price modifier table. This new policy will be permanently used during the whole simulation period. The new equation is:

T TPRMOD=1/.95/.90/.85/.80/.75/.70/.65/.60/.55/.50

TPRMOD Table constant values for price modifier

Figure 7.1 shows the new relationship between the inventory to past new orders ratio and the price modifier.

The new policy of dividends is designed to give the company the maximum flexibility possible in its growth objectives. It is a double policy. During the first stage the company will not pay any dividends to its stockholders.

A DIVID1.K=0

DIVID1 Dividends to be paid in the first stage ($/quarter)

During the second stage, dividends equal to the minimum of earned profit and unneeded cash will be paid each quarter. This is represented in the next equation:

A DIVID2.K=MIN((PROFT.K)(PROCT),UNNDC2.K)

DIVID2	Dividends to be paid in the second stage ($)
PROFT	New profit ($/quarter)
UNNDC2	Unneeded cash in the second stage ($)
MIN	Dynamo minimizing function

The control of which policy is to be applied in the model is obtained by the following equation:

```
R    DIVID.KL=CLIP(DIVID1.K,DIVID2.K/DIVPT,INDREC.K,1)
C    DIVPT=1
```

DIVID	Total dividends to be paid ($/quarter)
DIVID1	Dividends to be paid in the first stage ($/quarter)
DIVID2	Dividends to be paid in the second stage ($)
DIVPT	Dividends payment time (quarters)
INDREC	Index record

The new policy of capacity investment is also double. During the first stage the desired new capacity is defined by:

```
A    DNCAP1.K=CLIP(MINCD.K+CDONS.K,MAXCD,K,MAXCD,K,MINCD.K+
     CDOND.K)
```

DNCAP1	Desired new capacity in the first stage ($)
MINCD	Minimum capacity desired ($)

CDONS   Capacity desired indicated by orders not shipped ($)

MAXCD   Maximum capacity desired ($)

The only difference between this and the original policy is that this policy limits the value of desired new capacity both with a minimum value already defined and with a maximum value which is defined by:

A   MAXCD.K=(CAPEF.K)(.15)

MAXCD   Maximum capacity desired ($)

CAPEF   Effective capacity ($)

Observe that a new variable was introduced to simplify the expression for desired new capacity. This variable is the necessary capacity investment to cover orders not shipped.

A   CDONS.K=ORDNS.K/CAPPR

C   CAPPR=1

CDONS   Capacity desired indicated by orders not shipped ($)

ORDNS   Orders not shipped (units/quarter)

CAPPR Capacity productivity (units/quarter/$)

This policy limits the value of new investment in capacity each quarter to 15% of the value of effective capacity. It is designed to prevent undesirable jumps in capacity.

The policy that is followed in the second stage is very similar to that of the first stage, the only difference is that the second term of desired new capacity is reduced by 20%, to decrease under and overcapacity conditions. The equation for desired new capacity in the second stage is:

A DNCAP2,K=CLIP(MINCD.K+(CDONS.K)(.80),MAXCD.K,MAXCD.K,
(CDONS.K)(.80)+MINCD.K)

DNCAP2	Desired new capacity for the second stage ($)
MINCD	Minimum capacity desired ($)
CDONS	Capacity desired indicated by orders not shipped ($)
MAXCD	Maximum capacity desired ($)
CLIP	Dynamo decision function

Both policies are not complete without the statement of the limiting value of the new capacity buying rate. The limiting value was already established in the original model and it is called extra cash for investment. The two equations that set the new value of capacity investment are:

```
A     CAPBY1.K=CLIP(DNCAP1.K,XCASH.K,XCASH.K,DNCAP1.K)
A     CAPBY2.K=CLIP(DNCAP2.K,XCASH.K,XCASH.K,DNCAP2.K)
```

CAPBY#	Capacity buying rate auxiliary for # stage ($)
DNCAP#	Desired new capacity for # stage ($)
XCASH	Extra cash for investment ($)

Given that the policy is changed after the first stage, the capacity buying rate equation is written:

```
R     CAPBY.KL=CLIP(CAPBY1.K,CAPBY2.K,INDREC.K,1)/CPBYT
C     CPBYT=1
```

CAPBY	Capacity buying rate ($/quarter)
CAPBY#	Capacity buying rate for # stage ($)
INDREC	Index record
CPBYT	Capacity buying time (quarters)
CLIP	Dynamo decision function

The policy of external financing is modified only for the first stage. During the second stage it keeps its original form

A   NLTDR2.K=0

NLTDR2	New long term debt requested for second stage ($)

The equation for the first stage states that desired new long term debt will be equal to the difference of 25% of the value of equity and the value of long term debt, plus the value of long term debt that will be repaid in the following period. This means that a long term debt to equity ratio of 25% is desirable. The last term is used to reduce variations in long term debt due to the delay involved in obtaining external funds after they are requested.

```
A    DNLTD.K=(EQUITY.K)(.25)-LTDBT.K+(LTDSM.K/LTDRT)(PAYT)
C    LTDRT=16
C    PAYT=1
```

DNLTD	Desired new long term debt ($)
EQUITY	Stockholders equity ($)
LTDBT	Long term debt ($)
LTDSM	Long term debt contracts sum ($)
LTDRT	Long term debt repayment time (quarters)
PAYT	Payment time for repayments (quarters)

All requests are limited by the maximum new long term debt desired, which the company sets equal to the same value of maximum desired new capacity. The maximum value of new long term debt requested is given by:

A MNLTD.K=(CAPEF.K)(.80)

MNLTD	Maximum new long term debt ($)
CAPEF	Effective capacity ($)

The equation for new long term debt requested for the first stage is:

A NLTDR1.K=CLIP(DNLTD.K,MNLTD.K,MNLTD.K,DNLTD.K)

NLTDR1	New long term debt for first stage ($)
DNLTD	Desired new long term debt ($)
MNLTD	Maximum new long term debt ($)
CLIP	Dynamo decision function

Both the policy for the first and second stage are introduced in the equation for the rate of new long term debt requested.

A NLTDR.K=CLIP(NLTDR1.K,NLTDR2.K,INDREC.K,1)

NLTDR	New long term debt requested ($)
NLTDR#	New long term debt requested in stage # ($)
INDREC	Index record
CLIP	Dynamo decision function

C. Behavior of the Model with New Policies

The new financial policies were introduced in the original model and a new simulation run was done. The variables and scales used were not altered.

The resulting behavior can be observed in Figure 7.2. Again, the behavior of the variables is different in the two stages. This was expected for two reasons: First, because of the external condition existent, that is, the potential sales values, and second, because of three of the policies introduced in this chapter.

It is seen that price controls the raising inventory effectively in periods of overcapacity. The pricing policy is partially responsible for the big reduction in oscillatory amplitude of effective capacity in the second stage.

The dividend policy is partially responsible for the faster growth rate during the first state. Observe that the value of the accumulated dividends is zero from quarters 1 through 28. During the second stage, dividends accumulated increase exponentially as it is expected when there is a continuous growth in profit.

The new policy of external financing is also responsible

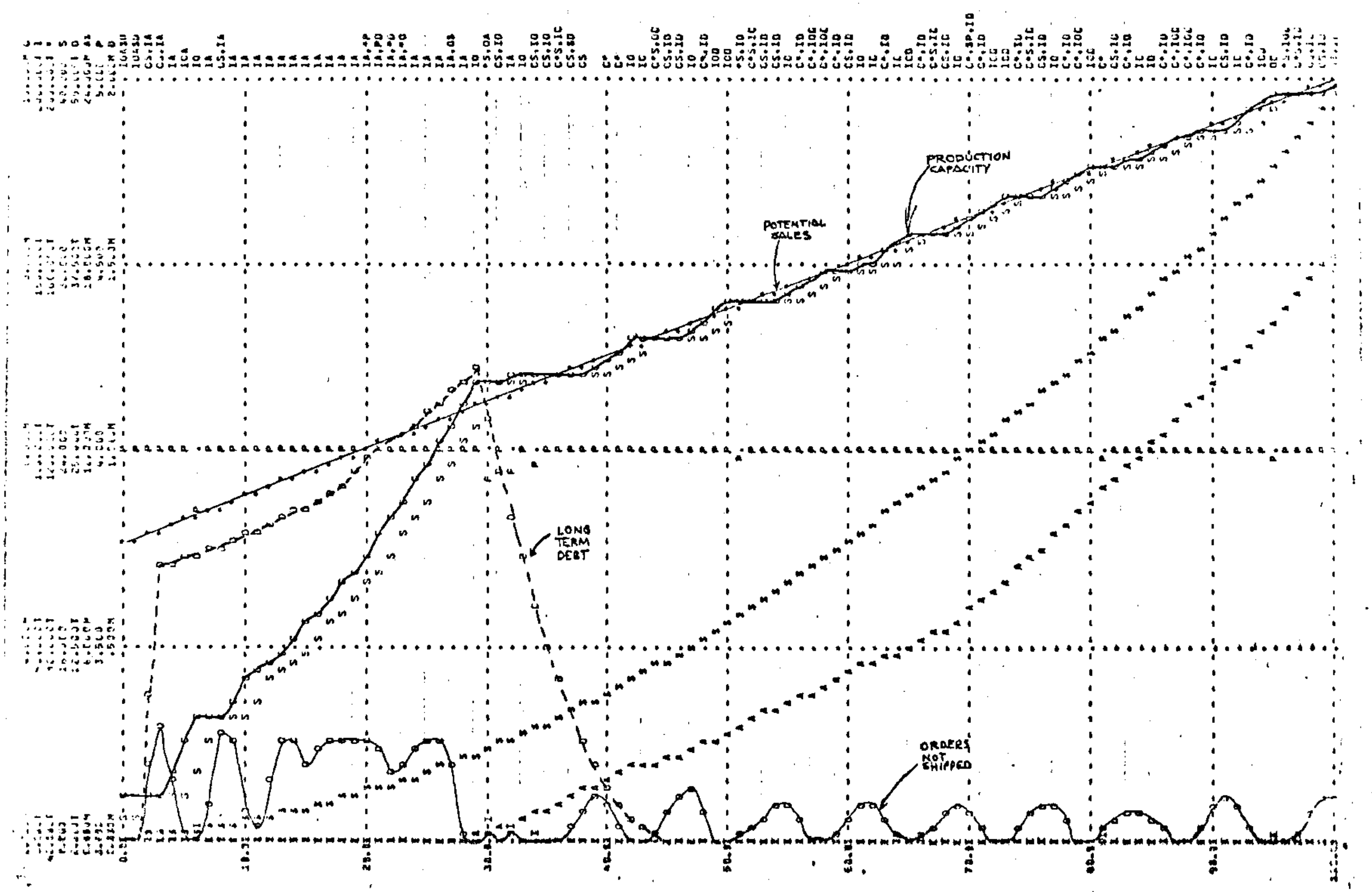


Figure 7.2. Behavior of the Improved Model

for the faster growth seen during the first stage. Observe that both the value of long term debt and effective capacity are increased very rapidly in the initial quarters. The company did not have any long term debt at the start of the simulation period but after one year, it reaches the limiting value permitted by the maximum long term debt to equity ratio permitted by the financial institutions.

The capacity policy for the second stage is partially responsible for the reduction of the amplitude of oscillation of effective capacity in the second stage.

Quantitatively, the company ends with an accumulated amount of dividends interest and surplus of $23.431 million, which is $2.756 million more than in the original model.

Important too is the fact that the level of potential sales is reached in almost half of the time. The level of capacity effective is equivalent to the level of potential sales in the 28th quarter, that is, 26 quarters before than in the original model.

A summarizing statement for the behavior of the model with the new policies may be: The company grew almost twice as fast and had fewer problems during the second stage. Both improvements are indicated in the $2.756 million extra, obtained with the new set of policies.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

A model was constructed in Chapter V to serve as a means to study the influence of some financial policies on corporate growth. This model was run in a computer and several plots were obtained. The quantitative and qualitative results of several changes in original policies were used in developing understanding of the model and its policies. This understanding was the basis for the development of an improved policies model which was presented in Chapter VII.

There have been many rewarding results of this research, most of which are personal. Two kinds of personal results were:

(1) The author had an outstanding chance to apply and test his previously acquired knowledge of general Management, Finance and Accounting, and of Feedback Dynamics. Some knowledge was directly applied in the design of the study and the model. Some other was indirectly applied and observed during the analysis and improvement stage of this research.

(2) The methodology of feedback dynamics, some of its

difficulties and some of its advantages, was experienced as a result of doing this research.

Some specific limitations of the model and conclusions derived from Chapters VI and VII are written below:

(1) The formulation of the production rate does not represent the usual actual situation encountered in a manufacturing company. In this formulation it is being assumed that the dollar value of installed capacity is the generator of production, where in fact, the capability of each machine installed is the important variable. Under an inflation economy, such as the one observed in Mexico, this formulation would be unrealistic.

(2) The formulation of desired new capacity is not commonly found in a young rapidly growing company. The dominating consideration in expanding capacity is to handle unsatisfied demand. This formulation does not estimate the potential demand and does not include the attitude of the managers toward a gap between production and demand.

(3) The potential sales formulation is rather limited because it does not include competition, which is an important factor in young growing markets.

(4) An exploration with a smaller value of the calculation time, DT = .5, was made to test the sensitivity of the model behavior to this parameter. Only minor variations were found in the second stage of growth.

(5) All of the financial policies studied have a

significant influence on the behavior of capacity and earnings growth. It was shown that the policy of dividends and of external financing are critical during the first stage of growth. The dominant feedback loop controlling the growth behavior during the first stage is a financial loop. Growth is limited only by the availability of funds for expansion. The company desires to expand capacity faster but only achieves that expansion permitted by available funds. During the second stage there is a change in feedback loop dominance. The company does not have critical financial limitations. The negative feedback loop containing desired new capacity is dominant during this stage and produces an oscillatory pattern of capacity growth. Control is exercised as a function of the existence of backorders.

(6) The set of improved policies were designed to achieve faster level of production capacity comparable to the level of potential sales and to decrease the tendency for oscillation. The first result is achieved by not paying any dividends during the first growth stage and by the use of external financing. This means that a positive loop is reinforced because all earnings are reinvested. A new positive feedback loop is created by the new policy of external financing. These two positive loops are responsible for a faster rate of growth during the first stage. The second result is achieved by a faster reaction to over-capacity conditions. The negative loop containing the pricing

policy reacts faster to a change in inventory. A reduction of the tendency for oscillation is also achieved by a more conservative capacity investment policy. In this case management reacts less strongly to the existence of back-orders during the second stage.

(7) Some other non-financial policies also result in improvements when they are studied and redesigned. Although it was not mentioned in Chapter VII, a redesign of the salesmen hiring policy results in a final value of DIVSRP \$0.628 million higher than the one obtained with the improvement of the financial policies alone.

General conclusions about the work done can also be written:

(1) A research of this sort can increase the knowledge and understanding of the Feedback Dynamics methodology.

(2) Financial policies and decision making processes can be studied with the use of the methodology of Feedback Dynamics.

(3) The need for a good understanding of the relationships and variables to be studied was evidenced during the modeling period of this research.

B. Recommendations

(1) A new formulation of the production rate is desirable. It should be based in machine production

capability and not on their book value.

(2) A more complete study of the effects of competition on potential sales and of the way that management decides to increase capacity is necessary. A very important feedback loop for the first stage would be created if these two modifications were considered. The critical policy of how fast to grow given a gap between production and demand would be interesting to explore. This would make considerations of other sources of external financing, such as common stock of preferred stock, necessary.

(3) The model should be reviewed to avoid changes in behavior resulting from changes in the calculation time DT.

(4) Adjustment times for all of the important accumulations (capital, salesmen, inventory, backlog, cash, debt, etc.) are included as constant values equal to one quarter. In practice these are variables with different values depending on their function. In fact the nature of the dynamic performance results largely from the values and changes in these adjustment times. A thorough exploration of these factors is of primary importance in future work.

(5) Since the payment of taxes is an important financial consideration in most of the companies, they should be included as an outflow for the cash level and consequently as a limit to growth.

APPENDIX A

```
*       EQUATION LISTING FOR THE ORIGINAL MODEL
NOTE
NOTE
NOTE    ************  ARRAY VARIABLES  ************************************
NOTE
DMNSN CAPACC(40),LTDACC(16),CAPRAT(40),LTDRAT(16)
FOR     CAPPER(1,40)
FOR     CAPPR2(2,40)
FOR     LTDPER(1,16)
FOR     LTDPR2(2,16)
NOTE
NOTE    ******************  ACCUMULATIONS  ********************************
NOTE
L       ACASH.K=ACASH.J+(DT)(PAYMT.JK+LTDIN.JK+CMNIN.JK-PYBOT.JK-LTDOT.JK-
X1      CAPBY.JK-PRODC.JK-SLMSL.JK-FINEX.JK-INVCT.JK-DIVID.JK)
L       RECIV.K=RECIV.J+(DT)(RECIN.JK-PAYMT.JK)
L       INVEN.K=INVEN.J+(DT)(PROD.JK-SHIPM.JK)
L       CAPOI.K=CAPOI.J+(DT)(CAPBY.JK-CAPIN.JK)
L       CAPEF.K=CAPEF.J+(DT)(CAPIN.JK-CAPRAT.JK(40))
L       NTCAP.K=NTCAP.J+(DT)(CAPIN.JK-CAPDP.JK)
L       CAPACC.K(1)=CAPACC.J(1)+(DT)(CAPIN.JK-CAPRAT.JK(1))
L       CAPACC.K(CAPPR2)=CAPACC.J(CAPPR2)+(DT)(CAPRAT.JK(CAPPR2-1)-CAPRAT.
X1      JK(CAPPR2))
L       ACCPY.K=ACCPY.J+(DT)(PYBIN.JK-PYBOT.JK)
L       LTDBT.K=LTDBT.J+(DT)(LTDIN.JK-LTDOT.JK)
L       LTDR.K=LTDR.J+(DT)(1/PDLAY)(MLTDR.JK-LTDR.J)
L       LTDACC.K(1)=LTDACC.J(1)+(DT)(LTDIN.JK-LTDRAT.JK(1))
L       LTDACC.K(LTDPR2)=LTDACC.J(LTDPR2)+(DT)(LTDRAT.JK(LTDPR2-1)-LTDRAT.
X1      JK(LTDPR2))
L       CMNST.K=CMNST.J+(DT)(CMNIN.JK-0)
L       SRPLS.K=SRPLS.J+(DT)((SHIPM.JK)(PRICE.J-UPROC-UMATC)-CAPDP.JK-SLMS
X1      L.JK-INVCT.JK-FINEX.JK-DIVID.JK)
L       DIVIDN.K=DIVIDN.J+(DT)(DIVID.JK+DIVINT.JK)
L       SLMTR.K=SLMTR.J+(DT)(SLMHR.JK-SLMIN.JK)
L       SLMEF.K=SLMEF.J+(DT)(SLMIN.JK)
L       POTSL.K=POTSL.J+(DT)(PTSIN.JK-0)
L       BKORD.K=BKORD.J+(DT)(BKOIN.JK-BKOOT.JK)
NOTE
NOTE    ****************  INITIAL VALUES  *********************************
NOTE
N       ACASH=CACASH
N       RECIV=CRECIV
N       INVEN=CINVEN
N       CAPOI=CCAPOI
N       CAPEF=CCAPEF
N       NTCAP=CCAPEF
N       CAPACC(CAPPER)=CCAPEF/40
N       ACCPY=CACCPY
N       LTDBT=CLTDBT
N       LTDR=CLTDR
N       LTDACC(1)=CLTDA1
N       LTDACC(LTDPR2)=CLTDAT
N       CMNST=CCMNST
N       SRPLS=CSRPLS
N       SLMTR=CSLMTR
N       DIVIDN=0
N       SLMEF=CSLMEF
N       POTSL=CPOTSL
N       BKORD=CBKORD
NOTE
NOTE    ************************  FLOWS  **********************************
NOTE
R       PROD.KL=(CAPEF.K)(CAPPR)
R       PRODC.KL=(CAPEF.K)(CAPPR)(UPRDC)
```

```
R       SHIPM.KL=MIN(ORDRS.K,AVGDS.K/SHIPT)
R       RECIN.KL=(MIN(ORDRS.K,AVGDS.K/SHIFT))(PRICE.K)
R       PAYMT.KL=RECIV.K/RPYMT
R       INVCT.KL=(INVEN.K)(UINVC)
R       CAPBY.KL=CAPBYA.K/CPBYT
R       CAPIN.KL=CAPOI.K/INSTT
R       CAPDP.KL=(CAPSM.K)(DPPRI)
R       CAPRAT.KL(CAPPER)=CAPACC.K(CAPPER)/RATT
R       PYBIN.KL=(CAPEF.K)(CAPPR)(UMATC)
R       PYBOT.KL=ACCPY.K/APYMT
R       NLTDR.KL=0
R       LTDIN.KL=LTDRM.K/LTDDT
R       LTDOT.KL=LTDSM.K/LTDRT
R       LTDRAT.KL(LTDPER)=LTDACC.K(LTDPER)/RATT
R       FINEX.KL=(LTDBT.K)(LTDIR)
R       CMNIN.KL=0
R       DIVID.KL=MAX(DIVIDA.K/DIVPT,MINDIV.K)
R       DIVINT.KL=(DIVIDN.K)(DIVIR)
R       SLMHR.KL=SLMND.K/HIRGT
R       SLMIN.KL=SLMTR.K/TRNGT
R       SLMSL.KL=(TSLMN.K)(AVSAL)
R       PTSIN.KL=(CPOTSL)(GROW)
R       BKOIN.KL=(ORDNS.K)(PCTBK)
R       BKOOT.KL=BKORD.K/WAITT
R       NEWORR.KL=NEWOR.K
NOTE
NOTE    *******************  AUXILIARIES  ********************************
NOTE
A       XCASH.K=MAX(0,ACASH.K-MICASH.K)
A       MICASH.K=(COVER)(FINEX.JK+LTDOT.JK)
A       UNNDC.K=MIN((PROFT.K)(PROCT),XCASH.K-DNCAP.K)
A       CAPSM.K=SUMV(CAPACC.K,1,40)
A       CAPBYA.K=CLIP(DNCAP.K,XCASH.K,XCASH.K,DNCAP.K)
A       DNCAP.K=MINCD.K+ORDNS.K/CAPPR
A       MINCD.K=CAPACC.K(39)
A       LTDSM.K=SUMV(LTDACC.K,1,16)
A       LTDRM.K=MIN(LTDR.K,NLTDM.K)
A       NLTDM.K=MAX(0,(MRATIO-RATIO.K)(EQUITY.K))
A       DIVIDA.K=MAX(0,UNNDC.K)
A       MINDIV.K=(MIDPC)(CMNST.K)
A       DINVEN.K=(INVEN.K)(UPRDC+UMATC)
A       INORR.K=INVEN.K/NEWORP.K
A       PRMOD.K=TABHL(TPRMOD,INORR.K,0,1,.1)
T       TPRMOD=1/1/1/1/.98/.96/.94/.92/.90/.88/.86
A       PRICE.K=(NPRICE)(PRMOD.K)
A       PRMLT.K=TABHL(TPRMLT,PRICE.K,3.4,4,.1)
T       TPRMLT=1.6/1.5/1.4/1.3/1.2/1.1/1
A       MAXOR.K=(SLMEF.K)(MORSL)
A       NEWOR.K=MIN(POTSL.K,MAXOR.K)
A       NEWORP.K=(NEWORR.JK)(NOAGT)
A       NWORM.K=(NEWOR.K)(PRMLT.K)
A       ORDRS.K=BKORD.K/SHIPT+NWORM.K
A       ORDNS.K=MAX(0,NWORM.K-AVGAB.K/SHIPT)
A       AVGAB.K=MAX(0,AVGDS.K-BKORD.K)
A       AVGDS.K=INVEN.K+(CAPEF.K)(CAPPR)(PRODT)
A       TSLMN.K=SLMTR.K+SLMEF.K
A       SLMND.K=MAX(0,SLMDS.K-TSLMN.K)
A       SLMDS.K=(CAPEF.K)(CAPPR)/PRSLR
A       PROFT.K=RECIN.JK-(SHIPM.JK)(UPRDC+UMATC)-CAPDP.JK-INVCT.JK-SLMSL.J
X1      K-FINEX.JK
A       ROEQY.K=PROFT.K/EQUITY.K
A       ACROE.K=SRPLS.K/EQUITY.K
A       ASSETS.K=ACASH.K+RECIV.K+DINVEN.K+CAPOI.K+NTCAP.K
A       LPLSE.K=ACCPY.K+LTDBT.K+CMNST.K+SRPLS.K
```

```
A      EQUITY.K=SRPLS.K+CMNST.K
A      DIVSRP.K=DIVIDN.K+SRPLS.K
A      RATIO.K=LTDBT.K/EQUITY.K
NOTE
NOTE   ********************   CONSTANTS   **********************************
NOTE
C      CACASH=62500
C      CRECIV=200000
C      CINVEN=0
C      CCAPOI=62500
C      CCAPEF=2500000
C      CACCPY=25000
C      CLTDBT=0
C      CLTOR=0
C      CLTDA1=0
C      CLTDAT=0
C      CCMNST=2800000
C      CSRPLS=0
C      CSLMTR=0
C      CSLMEF=9.0909
C      CPOTSL=100000
C      CBKORD=0
C      CAPPR=.02
C      CFBYT=1
C      INSTT=1
C      PRODT=1
C      OPPRI=.025
C      RATT=1
C      LTDRT=16
C      AVSAL=2500
C      HIRGT=1
C      TRNGT=1
C      UMATC=.5
C      UPRDC=.5
C      NPRICE=4
C      APYMT=1
C      SHIPT=1
C      RPYMT=1
C      PRSLR=5000
C      GROW=.01
C      PCTBK=.5
C      WAITT=1
C      UINVC=.25
C      LTDIR=.015
C      LTDOT=1
C      RDLAY=1
C      COVER=1
C      MORSL=5500
C      DIVIR=.0125
C      DIVPT=1
C      MIDPC=.01
C      MRATIO=.25
C      PROCT=1
C      NOAGT=1
NOTE
NOTE   *************************   OUTPUT SPECIFICATIONS   *****************
NOTE
PRINT  ACASH/RECIV/INVEN/CAPOI/NTCAP/ASSETS
PRINT  ACCPY/LTDBT/CMNST/SRPLS/LPLSE/RATIO
PRINT  PROFT/ROEQY/PRICE/LTDR/NLTDM/LTDOT
PRINT  CAPBYA/DNCAP/MINCC/ORDRS/AVGDS/NEWOR
PRINT  DIVIDN/DIVSRP/CAPEF/ACROE/UNNOC/XCASH
PLOT   CAPEF=C(2E6,10E6)/INVEN=I(0,2E5)/POTSL=*(4E4,2E5)/SLMEF=S(8,40)/OR
X1     DNS=O(0,5E4)/DIVIDN=A,DIVSRP=$(0,24E6)/PRICE=P(3,5)/LTDBT=D(0,2E6)
```

APPENDIX B

L I S T   O F   V A R I A B L E S

************************* ACCUMULATIONS *******************************

L	ACASH	EXPECTED AVAILABLE CASH
L	RECIV	ACCOUNTS RECEIVABLE
L	INVEN	INVENTORY IN UNITS
L	CAPOI	CAPACITY ON INSTALLATION
L	CAPEF	CAPACITY EFFECTIVE
L	NTCAP	NET CAPACITY ACCOUNT
L	CAPACC(#)	CAPACITY WITH # QUARTERS OF SERVICE
L	ACCPY	ACCOUNTS PAYABLE
L	LTDBT	LONG TERM DEBT
L	LTDR	LONG TERM DEBT REQUESTED
L	LTDACC(#)	LONG TERM DEBT CONTRACT WITH # QUARTERS OF EXISTENCE
L	CMNST	COMMON STOCK
L	SRPLS	SURPLUS OR RETAINED EARNINGS
L	DIVIDN	ACCUMULATED DIVIDENDS PAID PLUS INTEREST
L	DIVINT	INTEREST PAID ON DIVIDENDS
L	SLMTR	SALESMEN IN TRAINING
L	SLMEF	SALESMEN EFFECTIVE
L	POTSL	POTENTIAL SALES IN UNITS
L	BKORD	BACKORDERS

************************** FLOWS **************************************

R	PROD	PRODUCTION RATE
R	PRODC	PRODUCTION COSTS
R	SHIPM	PRODUCT SHIPMENTS OR SALES
R	RECIN	ACCOUNTS RECEIVABLE INFLOW
R	PAYMT	PAYMENT OF ACCOUNTS RECEIVABLE
R	INVCT	INVENTORY COSTS
R	CAPBY	NEW CAPACITY BUYING RATE
R	CAPIN	CAPACITY EFFECTIVE INFLOW
R	CAPDP	CAPACITY DEPRECIATION
R	CAPRAT(#)	CAPACITY STARTING #+1 QUARTERS OF SERVICE
R	PYBIN	ACCOUNTS PAYABLE INFLOW
R	PYBOT	ACCOUNTS PAYABLE OUTFLOW
R	NLTDR	NEW LONG TERM DEBT REQUESTED
R	LTDIN	LONG TERM DEBT INFLOW
R	LTDOT	LONG TERM DEBT OUTFLOW
R	LTDRAT(#)	LONG TERM DEBT CONTRACT FINISHING # QUARTERS OF EXISTENCE
R	FINEX	FINANCIAL EXPENDITURES
R	CMNIN	COMMON STOCK INFLOW
R	DIVID	TOTAL NEW DIVIDENS PAID
R	SLMHR	NEW SALESMEN HIRING RATE
R	SLMIN	SALESMEN EFFECTIVE INFLOW
R	SLMSL	SALESMEN SALARIES
R	PTSIN	POTENTIAL SALES INFLOW
R	BKOIN	BACKORDERS INFLOW
R	BKOOT	BACKORDERS OUTFLOW
R	NEWORR	NEW ORDERS RATE

********************** AUXILIARIES ************************************

A	XCASH	EXTRA CASH FOR INVESTMENT
A	MICASH	MINIMUM CASH DESIRED
A	UNNDC	UNNEDED CASH
A	CAPSM	CAPACITY ACCOUNT SUM

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A      CAPBYA   CAPACITY BUYING AUXILIARY
A      DNCAP    TOTAL DESIRED NEW CAPACITY
A      MINCD    MINIMUM NEW CAPACITY DESIRED
A      LTDSM    LONG TERM DEBT CONTRACTS SUM
A      LTDRM    LONG TERM DEBT REQUESTED MODIFIED
A      NLTDM    NEW LONG TERM DEBT MAXIMUM
A      DIVIDA   DIVIDENDS AUXILIARY
A      MINDIV   MINIMUM DIVIDENDS PAID
A      DINVEN   INVENTORY IN DOLLARS
A      INORR    INVENTORY TO NEW ORDERS RATIO
A      PRMOD    PRICE MODIFIER
A      TPRMOD   TABLE VALUES FOR PRICE MODIFIER
A      PRICE    PRODUCT'S PRICE
A      PRMLT    PRICE MULTIPLIER ON SALES
T      TPRMLT   TABLE VALUES FOR PRICE MULTIPLIER
A      MAXOR    MAXIMUM NUMBER OF ORDERS
A      NEWOR    NEW ORDERS
A      NEWORP   NEW ORDERS IN THE PAST PERIOD
A      NWORM    NEW ORDERS MODIFIED
A      ORDRS    TOTAL NUMBER OF ORDERS
A      ORDNS    ORDERS NOT SHIPPED
A      AVGAB    EXPECTED AVAILABLE GOODS AFTER BACKORDERS
A      AVGDS    EXPECTED AVAILABLE GOODS FOR SALE
A      TSLMN    TOTAL SALESMEN
A      SLMND    NEW SALESMEN NEEDED
A      SLMDS    SALESMEN DESIRED
A      PROFT    NET PROFIT
A      ROEQY    RETURN ON EQUITY
A      ACROE    ACCUMULATED RETURN ON EQUITY
A      ASSET    TOTAL ASSETS
A      LPLSE    LIABILITIES PLUS EQUITY
A      EQUITY   TOTAL STOCKHOLDERS EQUITY
A      DIVSRP   ACCUMULATED DIVIDENDS PLUS INTEREST PLUS SURPLUS
A      RATIO    LONG TERM DEBT-EQUITY RATIO

****************************** CONSTANTS ******************************

C      CACASH   INITIAL VALUE OF ACASH
C      CRECIV   INITIAL VALUE OF RECIV
C      CINVEN   INITIAL VALUE OF INVEN
C      CCAPOI   INITIAL VALUE OF CCAPOI
C      CCAPEF   INITIAL VALUE OF CAPEF
C      CACCPY   INITIAL VALUE OF ACCPY
C      CLTDBT   INITIAL VALUE OF LTDBT
C      CLTDR    INITIAL VALUE OF LTDR
C      CLTDA1   INITIAL VALUE OF LTDACC(1)
C      CLTDAT   INITIAL VALUE OF LTDACC(LTDPR2)
C      CCMNST   INITIAL VALUE OF COMMON STOCK
C      CSRPLS   INITIAL VALUE OF SURPLUS
C      CSLMTR   INITIAL VALUE OF SLMTR
C      CSLMEF   INITIAL VALUE OF SLMEF
C      CPOTSL   INITIAL VALUE OF POTSL
C      CBKORD   INITIAL VALUE OF BKORD
C      CAPPR    CAPACITY PRODUCTIVITY
C      CABYT    CAPACITY BUIYNG TIME
C      INSTT    CAPACITY INSTALLATION TIME
C      PRODT    PRODUCTION TIME
C      DPPRI    DEPRECIATION PERIOD INVERSE
C      RATT     RATE OF TRANSFER TIME
C      LTDRT    LONG TERM DEBT REPAYMENT TIME
C      AVSAL    SALESMEN AVERAGE SALARY
C      HIRGT    HIRING ADJUSTMENT TIME
C      TRNGT    TRAINING TIME
C      UMATC    UNIT MATERIALS COST
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C      UPROC     UNIT PRODUCTION COST
C      NPRICE    NORMAL PRICE
C      APYMT     ACCOUNTS PAYABLE PAYMENT TIME
C      SHIPT     ORDERS SHIPMENT TIME
C      RPYMT     ACCOUNTS RECEIVABLE PAYMENT TIME
C      PRSLR     PRODUCTION TO SALESMEN RATIO
C      GROW      POTENTIAL SALES GROWTH RATE
C      PCTBK     PERCENT OF BACKORDERS FROM ORDERS NOT SHIPPED
C      WAITT     WAITING TIME
C      UINVC     UNIT INVENTORY COST
C      LTDIR     LONG TERM DEBT INTEREST RATE
C      LTDDT     LONG TERM DEBT DELIVERY TIME
C      RDLAY     LONG TERM DEBT REQUESTING DELAY
C      COVER     FINANCIAL COVERAGE FACTOR
C      MORSL     MAXIMUM ORDERS PER SALESMEN
C      DIVIR    DIVIDENDS INTEREST RATE
C      DIVPT     DIVIDENDS PAYING TIME
C      MIDPC     MINIMUM DIVIDEND PERCENT
C      MRATIO    MAXIMUM LONG TERM DEBT-EQUITY RATIO PERMITTED
C      PROCT     PROFIT CALCULATION TIME
C      NOAGT     NEW ORDERS AGE TIME

****************** SWITCH EQUATIONS ********************************

A      INDREC    INDEX RECORD
L      PINREC    PREVIOUS INDEX RECORD
A      INDEX     SWITCH INDEX
A      MAXORP    MAXIMUM ORDERS IN THE PAST PERIOD
R      MAXORR    MAXIMUM ORDERS RATE

******************** NEW POLICIES *********************************

A      CAPBY1    CAPACITY BUYING RATE FOR FIRST STAGE
A      CAPBY2    CAPACITY BUYING RATE FOR SECOND STAGE
A      DNCAP1    DESIRED NEW CAPACITY FOR FIRST STAGE
A      DNCAP2    DESIRED NEW CAPACITY FOR SECOND STAGE
A      MAXCD     MAXIMUM NEW CAPACITY DESIRED
A      NLTDR1    NEW LONG TERM DEBT REQUESTED FOR FIRST STAGE
A      NLTDR2    NEW LONG TERM REQUESTED FOR SECOND STAGE
A      DNLTD     DESIRED NEW LONG TERM DEBT
A      MNLTD     MAXIMUM NEW LONG TERM DEBT DESIRED
A      DIVID1    DIVIDENDS PAID FOR FIRST STAGE
A      DIVID2    DIVIDENDS PAID FOR SECOND STAGE
A      UNNDC2    UNNEDED CASH IN THE SECOND STAGE
A      CODNS     NEW CAPACITY DESIRED INDICATED BY "ORDNS"

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